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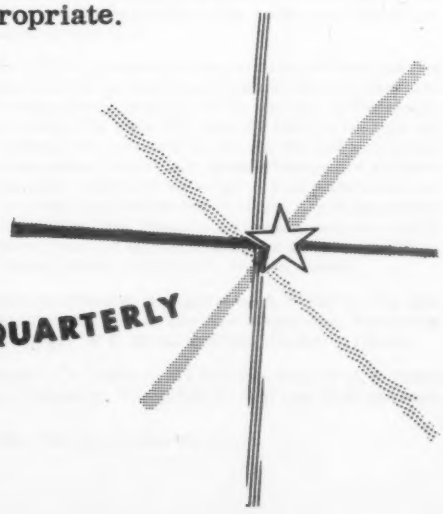

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*The printing of this publication has been approved by the Director of the Bureau of the Budget, July 30, 1957.*

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# NUCLEAR SCIENCE ABSTRACTS

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## GENERAL

**16863**

RADIOISOTOPES IN TECHNOLOGY: PRACTICAL APPLICATIONS OF ATOMIC ENERGY IN INDUSTRY (Radioisotopen in de Techniek: Praktische Toepassingen van Atoomenergie in de Bedrijven). T. Van Der Klis. Amsterdam, N. V. Uitgeversmaatschappij Diligentia, 1957. 151p. $4.25. (In Dutch)

The practical applications of radioisotopes in industry are reviewed. As an introduction the properties of radioisotopes and how to obtain them are discussed. A description is given of the instruments used for the detection and measurement of radiation. The use of gamma radiography in non-destructive materials testing is then described. Thickness, density, and level measurements form another industrial application. A brief survey is given of tracer techniques. Then the use of radioisotopes in the acceleration of chemical reactions, conservation of foods, direct production of electricity, and preparation of luminous paints is discussed. The final chapter concerns personnel protection. (J.S.R.)

## Atomic Bombs and Warfare

**16864** ARF-TM-D-1

Illinois Inst. of Tech., Chicago. Armour Research Foundation.

SOME PEACE TIME USES FOR NUCLEAR WEAPONS. F. B. Porzel. Sept. 23, 1957. 9p. $1.80(ph OTS); $1.80(mf OTS).

The containment of explosions in the ground is discussed. The use of such explosions to run heat engines and to produce controlled excavation is described. (T.R.H.)

**16865** ARF-TM-D-15

Illinois Inst. of Tech., Chicago. Armour Research Foundation.

EVALUATION OF TEMPERATURE DISTRIBUTION AND YIELD OF AN UNDERGROUND NUCLEAR EXPLOSION. [R. Budenholzer and H. J. Nielsen. Feb. 26, 1958.] 9p. $1.80(ph OTS); $1.80(mf OTS).

Laplace transformation is used to obtain the solution for temperature distribution around a bomb cavity as a function of time and distance from its center. (T.R.H.)

## Atomic Power

**16866** UCRL-5257(Rev.)

California. Univ., Livermore. Radiation Lab.

PEACEFUL USES OF FUSION. Edward Teller. July 3, 1958. 11p. Contract W-7405-eng-48. $3.30(ph OTS); $2.40(mf OTS).

Applications of thermonuclear energy for peaceful and constructive purposes are surveyed. Developments and problems in the release and control of fusion energy are reviewed. It is pointed out that the future of thermonuclear power reactors will depend upon the construction of a machine that produces more electric energy than it consumes. The fuel for thermonuclear reactors is cheap and practically inexhaustible. Thermonuclear reactors produce less dangerous radioactive materials than fission reactors, and when once brought under control are not as likely to be subject to dangerous excursions. The interaction of the hot plasma with magnetic fields opens the way for the direct production of electricity. It is possible that explosive fusion energy released underground may be harnessed for the production of electricity before the same feat is accomplished in controlled fusion processes. Applications of underground detonations of fission devices in mining and for the enhancement of oil flow in large low-specific-yield formations are also suggested. (C.H.)

**16867**

THE GERMAN ATOMIC RESEARCH CENTER AT KARLSRUHE. Atombrief 4, 229-46(1958). (In German)

The Atomic Research Center at Karlsruhe is described in detail. Separate articles are presented on the organization of the Nuclear Reactor Construction and Operating Company, design of the FR-2 reactor, cooperation with industry in planning the Center, the importance of the reactor for the Karlsruhe Technische Hochschule, organization of the radiation control program, the union of private enterprise and public planning, cooperation of the administration chief, and the industrial requirements. (J.S.R.)

**16868**

ENERGY CONSUMPTION RESEARCH AS A CONTRIBUTION TO THE FUTURE ECONOMIC DEVELOPMENT OF POWER PLANTS. Herbert F. Mueller. Atombrief 4, 253-5(1958). (In German)

The economic development of nuclear power plants requires a knowledge of future power needs. A brief survey is given of the systematic investigation being conducted in this field in Western Europe. (J.S.R.)

**16869**

APPLICATION OF RADIOISOTOPES IN IRRADIATION TESTING OF MATERIALS. Wolfgang Kolb. Atombrief 4, 288-95(1958). (In German).

As an introduction, testing techniques and financial aspects of radiation testing are described. The methods and apparatus used for this work are discussed. The use of gamma radiation in many industries is illustrated. (J.S.R.)

**16870**
NUCLEAR GENERATION IN THE UNITED KINGDOM. THE PROGRAMME AND THE POWER STATIONS. Nuclear Eng. 3, 375-8(1958) Sept.

The power generation program in the United Kingdom is discussed. Several of the existing and planned nuclear power stations are compared. (W.D.M.)

**16871**
PLANS AND PROJECTS OF HAWKER SIDDELEY N.P.C. E. P. Hawthorne (Hawker Siddeley N.P.C.). Nuclear Eng. 3, 384-6(1958) Sept.

The activities of the Hawker Siddeley Nuclear Power Company fall into three main categories. Project studies, design and construction of in-pile and out-of-pile experimental facilities, and research work in the physics, metallurgy, and material fields. (W.D.M.)

**16872**
WORLD NUCLEAR PROGRAMS. Nucleonics 16, No. 9, 62-5(1958) Sept.

The nuclear power programs of the various countries of the world were reported at Geneva. The papers presented considered nuclear power economics, national reactor program, and nuclear fuel supply. The national reactor programs of Canada, France, West Germany, Italy, Japan, the Netherlands, Sweden, United Kingdom, and the United States are summarized. (J.S.R.)

**16873**
APPLIED RADIATION. Nucleonics 16, No. 9, 86-91 (1958) Sept.

The papers presented at Geneva on applied radiation discussed new labeling techniques, nuclide production, tracing technology, radiation sources, radiation effects, and food preservation. (J.S.R.)

# BIOLOGY AND MEDICINE

## Radiation Effects

**16874** UCSF-17
California. Univ., San Francisco. School of Medicine. Radiological Lab.
SEMIANNUAL REPORT FOR PERIOD ENDING JUNE 30, 1958. Aug. 1958. 24p. Contract AT-11-1-Gen-10. Project No. 2. $1.00(OTS).

The 70-Mev synchrotron is described. Procedures used in dosage determinations are reviewed. Results of clinical applications for cancer therapy are summarized, and a number of case histories are presented. The advantages and disadvantages of the 70-Mev synchrotron for cancer therapy are tabulated. While the number of patients treated is not large enough to permit a statistical study, some remarkable results have been obtained. Preliminary results are reported from a study of the effects of radiation on the life span and litter size of mice. Factors influencing the radiobiologic action of cysteine in Escherichia coli were investigated and results compared with protective effects on mammals. (For preceding period see UCSF-16.)

**16875** AEC-tr-3373
STUDIES ON THE DOSE REQUIRED FOR DEPILATION. Peter Heil. Translated for Los Alamos Scientific Lab., N. Mex. from Strahlentherapie 103, 472-6(1957). 5p.

A consideration of the x-rays necessary to effect depilation in the region of hair papillae at the margin of depilated areas of hair along the back of the neck has led to the conclusion that the dose of soft x-rays below 50 kv required to bring about depilation in the region of the hair papillae may be up to half of the dose required for medium hard (80 to 85 kv) x-rays in use till now. (auth)

**16876** AEC-tr-3375
RADIOBIOLOGICAL EFFECTS OBTAINED WITH RADIATION FROM 30 MEV GENERATORS. H. R. Schinz and H. Fritz-Niggli. Translated for Los Alamos Scientific Lab., N. Mex. from Radiol. Clin. 25, 371(1956). 10p.

No qualitative differences were observed in the biological effects on a number of test systems of x rays produced by a 31-Mev betatron and an electron beam of comparable energy produced by a betatron. Quantitative differences were observed between conventional x rays and x rays produced by the 31-Mev betatron. The effectiveness of the latter is smaller by a factor of 0.6 to 0.9 depending on the object examined. Similar differences were observed between electrons generated by the 30-Mev betatron and conventional x rays. (C.H.)

**16877**
RESEARCH RESULTS IN THE APPLICATION ON IONIZING RADIATION TO TOBACCO. J. A. Schmidt. Atombrief 4, 299-302(1958). (In German)

Experiments on the physiological and genetic behavior of German tobacco varieties, whose seeds were exposed to ionizing radiation are described. The preservation of tobacco products by exposure to radiation is discussed. (tr-auth)

**16878**
EFFECT OF MATURITY AND X-RAY CASTRATION ON THE COLOR CENTERS OF THE RETINA IN CHELONIANS. André G. Pézard. Compt. rend. soc. biol. 152, 414-16(1958). (In French)

The turtles studied Emys orbicularis and Testudo Graeca were castrated by 400 or 500 r of x radiation administered in a single dose. A study of retina showed that the number of red centers were also halved, but the other color centers were increased. The young turtles had almost the same ratio of red centers to total color centers as the irradiated turtle. (J.S.R.)

**16879**
THE EFFECT OF X-RAY TREATMENT UPON PHOTOSYNTHESIS IN WHEAT PLANTS. I. M. Vasilev and N. D. Rybalka (Inst. of Biological Physics, Academy of Sciences, USSR). Doklady Akad. Nauk S.S.S.R. 121, 78-9(1958) July 1. (In Russian)

Studies of wheat sensitivity to x radiation showed that x radiation did not stop photosynthesis and that the plants left in light continued the accumulation of the dry substance even after exposure to 100,000 r. (R.V.J.)

**16880**
ON THE CAUSE OF INFUSORIA PERISHING IF EXPOSED TO X RAYS. E. G. Zinovieva. Doklady Akad. Nauk S.S.S.R. 121, 80-3(1958) July 1. (In Russian)

X radiation induces certain stable chemical changes in aqueous solutions which have a toxic effect on the Paramecium caudatum. Paramecium exposed to x radiation are more sensitive to the affects of irradiated aqueous media. The aqueous solution inhabited by infusoria previously to x irradiation is less toxic than irradiated pure water. (R.V.J.)

**16881**
AN INVESTIGATION OF THE EFFECT OF THE PHENYLAMIDINE OF 2-THIOPHENE CARBOXYLIC ACID ON THE RESISTANCE OF MICE TO LETHAL DOSES OF GAMMA-RAYS FROM $Co^{60}$. St. Robev

(Inst. of Specialization and Graduate Work in Medicine, Sofia). Doklady Akad. Nauk S.S.S.R. 121, 84-6(1958) July 1. (In Russian)

Protective properties of phenylamidine of 2-thiophene carboxylic acid were tested on 289 mice irradiated by 750 r of γ rays. The results showed that 54 mice (39.5%) treated with 1.5 mg αTA survived for 30 days after exposure while only 4 out of 150 (2.7%) control mice survived the same length of time. (R.V.J.)

**16882**

BIOACCUMULATION OF RADIOISOTOPES THROUGH AQUATIC FOOD CHAINS. J. J. Davis and R. F. Foster (General Electric Co., Richland, Wash.). Ecology 39, 530-5(1958) July.

Some radioactive materials introduced into aquatic environments may be accumulated by the organisms. The amount of accumulation will vary over many orders of magnitude depending upon the kinds of isotopes involved and many physical, chemical, and biological factors. Such concentration is of considerable importance in the control of radiological hazards and the aquatic biologist has definite responsibilities in this area. The processes of adsorption and absorption are of major importance in the uptake of radioisotopes by plants but appear to be of less importance than the food chain in the uptake by aquatic animals. The concentration of radioactive substances will vary between species and tissues and will fluctuate according to food habits, life cycles, and seasonal changes. Within the biotic mass, a major fraction of most radioactive contaminants will be held by the organisms which make up the primary trophic levels. In a flowing stream, the specific activity of a radioisotope will diminish along the food chain. Where the turnover rates of certain isotopes can be measured, inferences can be drawn on feeding habits. (auth)

**16883**

A STUDY OF THE TEMPERATURE DEPENDENCE OF RADIATION SENSITIVITY OF DRY SPORES OF BACILLUS MEGATERIUM BETWEEN 5°K AND 309°K. R. B. Webb, C. F. Ehret, and E. L. Powers (Argonne National Lab., Lemont, Ill.). Experientia 14, 324-6(1958).

The temperature dependence of the radiation sensitivity of dry spores of Bacillus megaterium was measured in the temperature range from 5 to 309°K. The sensitivity is temperature dependent below 130°K; it corresponds to the van-t'Hoff-Arrhenius rule between 130 and 310°K with an activation energy of 0.110 kcal. (tr-auth)

**16884**

INFLUENCE OF HORMONES AND X-RAYS UPON THE TISSUE MAST CELL. D. E. Smith and Yevette S. Lewis (Argonne National Lab., Lemont, Ill.). Experientia 14, 335-6(1958).

Different sexual and pituitary hormones were without effect on the labrocytes of the mesentery and skin of the rat. Partial irradiation of the rat and hamster causes significant alterations in the irradiated tissues, but it does not affect the non-irradiated tissues. (tr-auth)

**16885**

HAPLOIDY INDUCED BY RADIATIONS IN WHEAT. A. T. Natarajan and M. S. Swaminathan (Indian Agricultural Research Inst., New Delhi). Experientia 14, 336-7 (1958).

Irradiation of wheat spikes (Triticum aestivum L., variety N. P. 809) with 5200 r of x radiation shortly before anthesis, as well as the treatment of seeds and seedlings of the same plants with $P^{32}$ or $S^{35}$, produced haploid forms. (tr-auth)

**16886**

A SIMPLE ANALYTICAL METHOD FOR THE DETERMINATION OF THE RATIO OF THE MOTHER AND DAUGHTER SUBSTANCES IN RADIOACTIVE PREPARATIONS. A. Catsch (Institut für Strahlenbiologie an der Reaktor-Station, Karlsruhe, Germany). Experientia 14, 345-6(1958). (In German)

A simple and time saving numerical method is described which permits the rapid determination of mother to daughter ratios in biological specimens containing radionuclides. (auth)

**16887**

AN ANALYSIS OF THE REJOINING OF X-RAY-INDUCED BROKEN ENDS OF CHROMOSOMES IN THE ROOT TIPS OF ALLIUM CEPA. Norman S. Cohn (Johns Hopkins Univ., Baltimore). Genetics 43, 362-73(1958) May.

Experiments were performed with the roots of Allium cepa seedlings in order to analyze the rejoining behavior of x-ray-induced broken ends of chromosomes, and to test several hypotheses relating the results of such studies to the nature of chromosome organization. Studies with fractionated doses have shown that two classes of breaks, as judged by their average time of restitution, are induced by x-rays—those that undergo relatively rapid restitution within 15 minutes, and those that remain open for a relatively long period of time, e.g., four hours. In an effort to distinguish the two classes of breaks on a qualitative basis, experiments utilizing carbon monoxide treatments were performed. Carbon monoxide was found to produce a light-reversible inhibition of the restitution of both types of breaks. The results of these studies indicate that the two classes of breaks cannot be distinguished on this basis. The possibility that iron provides an ionic linkage in the chromosome is discussed. (auth)

**16888**

ASSESSING THE IMPACT OF ENVIRONMENTAL RADIATION ON TOTAL HEALTH. Paul S. Henshaw (United States Atomic Energy Commission, Washington). Health Phys. 1, 141-51(1958) Sept.

Ionizing radiation is but one of various agents that affect the stamina and well-being of population groups within species through induction of mutations in both the somatoplasm and the germplasm. A preliminary effort has been made to identify and examine central and pace-setting determinants of the life process, moving thereby toward a better understanding of the role and significance of radiation. On the basis of accumulated information and deductions that follow logically, questions have been raised regarding the part natural radiation may have had in shaping the character of life processes through time, possibly influencing both the course and rate of evolution and the average life-span of species, the matter of whether radiation, though injurious to cells, may not under certain circumstances have a beneficial effect in complex multicellular organisms, radiation as an agent acting to reduce the fitness reserve in organisms, and the limits of exposure so far as individual and group survival are concerned. A formulation has been developed which aids in visualizing the total health process and how this is affected positively and negatively by various factors, including radiation. By means of the formulation some impression is gained of the stability of the life process, on the one hand, and, on the other, of its extreme vulnerability if an environmental factor such as radiation is altered significantly. (auth)

**16889**

THE EFFECTS OF IRRADIATION ON LONGEVITY.

Shields Warren (New England Deaconess Hospital, Boston). Klin. Wochschr. 36, 597-9(1958) July 1. (In German)

Data on the effects of radiation exposure on life span are reviewed. The contribution of medical radiography to life-shortening is considered. (C.H.)

**16890**

RADIATION-INDUCED MUTATION RATES IN FEMALE MICE. W. L. Russell, Liane Brauch Russell, Josephine S. Gower, and Savanna C. Maddux (Oak Ridge National Lab., Tenn.). Proc. Natl. Acad. Sci. U. S. 44, 901-5 (1958) Sept.

Mutation rates in females have been measured by the specific locus method in two experiments. A relatively small experiment with acute x rays, at a dose which rapidly sterilizes females, was nevertheless sufficient to show that if the average risk of equal exposure of both sexes to acute x rays is calculated on the basis of the far more reliable rate determined in males, the hazard will almost certainly not be underestimated by more than a factor of 2. An experiment with chronic gamma rays, which allowed almost normal fertility of the females, has, to date, given a rate of $5 \times 10^{-8}$/r/ locus with a 95 per cent confidence interval of 0.6 to $18 \times 10^{-8}$. This rate is significantly below that of $28 \times 10^{-8}$/r/locus found in males irradiated with a similar dose of acute x irradiation. Possible reasons for the lower rate are discussed. Whatever the explanation turns out to be, the results indicate that the mutation rate in women exposed to chronic gamma radiation may be less than that estimated from our earlier yardstick, namely, the mutation rate obtained from acute x irradiation of male mice. (auth)

**16891**

EFFECT OF CORTISONE AND X-RADIATION ON RNA AND GLYCOGEN CONTENT OF RAT HEPATOCYTES. Charles U. Lowe, Royden N. Rand, and P. R. Venkataraman (Children's Hospital and Univ. of Buffalo School of Medicine, N. Y.). Proc. Soc. Exptl. Biol. Med. 98, 696-8(1958) Aug.-Sept.

Rats were treated with cortisone, x radiation and both agents in combination, and the effects noted on RNA and glycogen content of liver. Under various conditions of treatment, RNA content increased promptly to different degrees and returned to normal values at different times. Comparison of RNA content/liver in the present study, with those of DNA/nucleus in previous study, indicates that, in animals which received cortisone alone, the maximum increase in RNA was obtained 24 hours prior to a fall in concentration of DNA. However, accumulation of RNA in rats which received x-radiation or both cortisone and x-radiation was 48 hours earlier than when the fall of DNA became significant. X radiation or cortisone administration caused glycogen accumulation in liver, the former transiently, the latter in more dramatic and prolonged manner. X radiation, prior to administration of cortisone, modified the response and decreased glycogen accumulation. Changes in glycogen content in contradistinction to RNA could not be correlated with those of DNA. (auth)

**16892**

INFLUENCE OF X-IRRADIATION ON POTASSIUM RETENTIVITY BY ESCHERICHIA COLI. A. P. Harrison, Jr., A. K. Bruce, and G. E. Stapleton (Oak Ridge National Lab., Tenn.). Proc. Soc. Exptl. Biol. Med. 98, 740-3(1958) Aug.-Sept.

Potassium efflux from stationary-phase cells of Escherichia coli takes place readily in the presence of ammonium ions. Hence, through the use of ammonium phosphate buffer, $K^+$ efflux was studied at a set value of pH. Sodium ions, on the other hand, retard $K^+$ efflux, a finding that has been used to advantage when sodium phosphate is used as buffer in delaying efflux measurement. Potassium efflux from E. coli increases as a result of x irradiation. Amount of x-ray damage to $K^+$ retention mechanism varies inversely with cell concentration during irradiation. E. coli strain B is much more susceptible to this radiation damage than is its mutant B/r. (auth)

**16893**

INVESTIGATIONS ON THE EFFECT OF X RADIATION ON THE $C^{14}$-ALANINE SYNTHESIS IN THE PROTEIN OF LIVER HOMOGENATES AND TUMOR CELLS. Gerhard Schubert, Gerhard Bettendorf, Hans A. Klinkel, Heinrich Maass, and Günther Heinz Rathgen (Universitats-Frauenklinik Hamburg-Eppendorf). Strahlentherapie 106, 483-90(1958). (In German)

In experiments in vitro by means of $C^{14}$ alanine the authors have examined the influence of x rays on the protein synthesis of liver homogenates and of Yoshida ascites sarcoma cells. The results have shown that after irradiation of 5 kr no stoppage of the alanine incorporation into the protein can be observed. After 25 kr the tumor cells are subject to a reversible inhibition of the protein synthesis, which must, however, be considered as a consquence of the checked glycolysis and the corresponding deficiency of "energy-rich" phosphate. (auth)

**16894**

REPORT ON THE BIOLOGICAL AND BIOCHEMICAL EFFECT OF IONIZING RADIATIONS. I. OUTLINE OF THE CHEMISTRY OF IONIZING RADIATION. Hans-Joachim Maurer (Universitats-Frauenklinik, Erlangen). Strahlentherapie 106, 491-504(1958). (In German)

The importance of the hits theory in today's radiobiology is pointed out. The essential part of the study refers to the compiling of the results of radiochemical research on the primary effect of ionizing radiations, the observations made in vivo and in vitro having been separately dealt with. Changes caused by ionizing radiation in water and aqueous solutions are given preferential attention. Observations made on radiochemical changes which biologically important substances have undergone are reported, as these are especially relevant in relation with an active x-ray protection, in the form of medicaments. A short reference is made to the application of the results of radiochemistry in relation with biological changes after the effect displayed by ionizing radiations. (auth)

**16895**

RADIATION REACTION OF THE ATROPHIC UTERUS. Theophil Hornykiewytsch. Strahlentherapie 106, 505-22 (1958). (In German)

The irradiation of the atrophic uterus of rats with 4000 r effected progressive regressive-degenerative alterations of the epithelium and even the disappearance of the uterus lumen. In the loose connective tissue there was no other acute radiogenic reaction but an edema with a wave-like course. On account of the decreased function due to castration the development of the reaction in the uterus was delayed. The radiosensibility and the histological picture showed distinct changes in comparison with the stimulated organ. (auth)

**16896**

COMPARISON MEASUREMENTS ON THE DEEP EFFECT OF RADIOSTRONTIUM, RADIOYTTRIUM, RADIUM, AND SURFACE IRRADIATION. Hermann Mühleisen (Stadtischen Marienkrankenhauses, Amberg, Germany.). Strahlentherapie 106, 589-92(1958). (In German)

Reports are given on comparative measurements concerning the deep effect of radiostrontium, radio-yttrium, radium- and surface-therapy, judging the deep effect by the extent of the blackening of the film. The therapeutic consequences resulting of these measurings are discussed. (auth)

**16897**

INDIRECT DOSAGE IN INTRAUTERINE IRRADIATION BY COBALT-60 BEADS. Dietrich Buttenberg and Hans Lau (Universitäts-Frauenklinik, Heidelberg). Strahlentherapie 106, 593-600(1958). (In German)

A method of indirect dosage of ionizing rays in intrauterine application of radiocobalt beads with special regard to the maximum charge of bladder and rectum is reported. By means of isodose planes and measurement results which were gathered with 102 fillings it is shown that this method of dosage responds best to the anatomical differences and the variability of the source of radiation. With the method of indirect dosage a tumor destruction dose may be reached at the uterus without supra-lethal effect, while at the same time bladder and intestine are surely protected from being overcharged. Another advantage consists in the simple and sure handling which hardly encumbers the examining officer. A metal cover designed for the gammameter of Siemens-Reiniger, Erlangen, enables measurements to be carried out in bladder and intestine with this apparatus. The method of indirect dosage has proved its value with 70 patients (102 fillings). (auth)

## Radiation Hazards and Protection

*Refer also to abstracts 17050 and 17315.*

**16898** AECU-3823

Columbia Univ., New York. Lamont Geological Observatory.

THE LAMONT SEA WATER RADIOCARBON PROGRAM, 1957–1958. M. Ewing, R. Gerard, and W. Broecker. Aug. 1958. 24p. Contract AT(30-1)-1808. (CU-2-57-AT(30-1)-1808-Geol.). $4.80(ph OTS); $2.70(mf OTS).

Measurements have been made on 40 sea water radiocarbon samples collected during the VEMA-12 cruise of December 1956-July 1957. Of these measurements 13 represent surface samples and 27 are from subsurface depths. The samples were obtained from water masses in the North Atlantic, South Atlantic, and Caribbean. In addition, 15 sea water radiocarbon samples from previous cruises were recounted and in certain cases their $C^{14}/C^{12}$ ratios corrected. With these additions and corrections Lamont Observatory has now obtained radiocarbon measurements on a total of 109 sea water samples with a precision of greater than one percent. (auth)

**16899** USNRDL-TR-249

Naval Radiological Defense Lab., San Francisco.

A THEORY FOR CLOSE-IN FALLOUT. A. D. Anderson. July 23, 1958. 64p.

A theory for close-in fall–out, believed applicable for all nuclear weapon yields, was derived to meet the need for a physical explanation of the fall–out process. Since it was found that most of the radioactive fall–out was created within relatively short times after detonation, while the visible nuclear cloud was still rising, the theory attempts to take into account the motion of the fall–out particles practically from the time of their inception in the fireball until they finally return to the ground. It does this by considering the effect of the visible cloud rise on a particle's rise and fall and the effect of the winds in displacing the particle horizontally —the resultant motion is the particle trajectory. By combining the particle-trajectory data with weighting factors for mass or activity, the theory may be used to find at any specified time of interest after detonation: distributions of particle sizes by weight or activity present within selected altitude ranges; and fraction of initial-visible-cloud activity or mass present in any altitude range or deposited on the ground. Also, it is possible to make quantitative predictions of mass concentration or activity present at any point at any time of interest, either on the ground or at any specified altitude. With knowledge of the radiation energy spectra of these sources and the attenuating characteristics of the air and ground surface, it is possible to compute the dose rates for the radioactive material deposited on the ground or still falling through the air, and thus compute deposit doses and transit doses. (auth)

**16900** WASH-1002(Pt. II and Suppl.)

Division of Biology and Medicine, AEC.

A SELECTED LIST OF REFERENCES OF PLUTONIUM HAZARDS. PART II. Alfred W. Klement, Jr., comp. Feb. 25, 1958. 6p. SUPPLEMENT. Mar. 17, 1958. 4p. $3.30(ph OTS); $2.40(mf OTS).

A bibliography of 140 references to books, technical reports, and journal articles on the hazards of Pu is presented. (T.R.H.)

**16901**

HEALTH PHYSICS AND THE NUCLEAR ENERGY INDUSTRY. W. R. McMurray (National Physical Research Lab., Pretoria). Atomics and Energy, Suppl. to Industrial Review of Africa. 5p.(1958) Apr.

The role of health physics in a nuclear energy program is summarized. (C.H.)

**16902**

STRONTIUM IN DIET. F. J. Bryant, A. C. Chamberlain, G. S. Spicer, and M. S. W. Webb (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Brit. Med. J. 1, 1371-5(1958) June 14.

Measurements have been made of the stable strontium and strontium 90 content of various articles in diet in four regions of Britain in 1957 and estimates of the content of typical adult diets deduced. The mean ratios of strontium to calcium are: stable strontium/calcium = 1200 $\mu$g/g, and strontium 90/calcium = 5.5 $\mu\mu$c/g. The average stable strontium content of adult human bone in Britain is 300 $\mu$g per gram of calcium. There therefore appears to be a 4:1 discrimination against strontium relative to calcium in human metabolism. Assuming the same to apply to strontium 90, the strontium 90/calcium ratio on new bone derived from average diet should be 1.4 Sunshine Units. (auth)

**16903**

HISTORY OF THE INTERNATIONAL COMMISSION ON RADIOLOGICAL PROTECTION (ICRP). Lauriston S. Taylor. Health Phys. 1, 97-104(1958) Sept.

The ICRP was established by the second International Congress of Radiology in 1928. Since this time the Commission has established the basic pattern for radiation protection recommendations that have gone into use throughout the world. The first quantitative value of permissible dose was promulgated in 1934 and remained in effect until 1950. In 1950 the MPD was lowered by a factor of about 2, and in 1956 it was again lowered by a factor of about 3. In addition to the development of the basic concept of MPD, the Commission has also adopted maximum permissible concentrations of radioactive materials in air and water and the whole body. (auth)

16904

POTENTIAL HAZARD OF WORLD-WIDE $Sr^{90}$ FALLOUT FROM NUCLEAR WEAPONS TESTING. Wright H. Langham (Los Alamos Scientific Lab., N. Mex.). Health Phys. 1, 105-24(1958) Sept.

Because of the chemical similarity of strontium and calcium, $Sr^{90}$ from weapons tests has found its way into the biosphere and into the bones of man. Two theories as to the mechanism of world-wide fallout have been proposed. The Libby theory proposes rapid stratospheric mixing with uniform leakage back into the troposphere where the fallout is deposited according to meteorological patterns. The Maghta theory proposes slow stratospheric mixing with unequal leakage back from the stratosphere as a result of tropospheric-stratospheric air mixing in the vicinity of the jet streams. Surface build-up in the population belts near 40°N and 40°S latitude may be higher on the basis of the Maghta theory. At present, surface concentrations of $Sr^{90}$ in the northern United States is approaching 30 mc/mile$^2$. On the basis of ecological data, soil analyses, and bone analyses, present average maximum equilibrium bone levels in the northern United States is estimated at about 2 pc/g Ca. Assuming no more weapons tests, these levels may reach 3–4 pc/g Ca. Because of inequalities in soil calcium, biological variations, etc., a few individuals may approach bone levels three to five times the average. If biospheric $Sr^{90}$ contamination continues indefinitely at the rate indicated during the past 5 years, average equilibrium levels may increase by a factor of about 10. In the event of war, exploding 20,000 MT equivalents of fission may bring the average maximum equilibrium bone levels in the world population belts to 1000 pc/g Ca, the maximum permissible level for atomic workers. Two thousand megaton equivalents of fission would bring the average maximum equilibrium level to about 100 pc/g Ca, the maximum permissible level for large areas of population. The possible significance of present and future $Sr^{90}$ bone levels is discussed in terms of world health using, as a basis, the life-time natural background radiation to the bone. Much of the present controversy over the significance of $Sr^{90}$ fallout results from disagreement over whether such chronic effects as leukemia and bone sarcoma are threshold or nonthreshold phenomena and over what is an acceptable maximum permissible $Sr^{90}$ bone level for the world population. Present $Sr^{90}$ levels in the population are not great enough to be of any significance to world health. Whether weapons tests should or should not be stopped depends on the importance of maintenance of a balance in nuclear weapons in averting nuclear war. This answer cannot be derived from $Sr^{90}$ fallout data. (auth)

16905

CURRENT STATUS OF THE INTERNAL DOSE PROBLEM. K. Z. Morgan (Oak Ridge National Lab., Tenn.). Health Phys. 1, 125-34(1958) Sept.

There are MPC values for many additional radionuclides in the revised handbooks of the National Committee on Radiation Protection, NCRP, and of the International Commission on Radiological Protection, ICRP. The basic philosophy and principal standards used in obtaining these MPC values have not changed. The MPC values are calculated on the basis of a dose rate of 0.6 rem/week to the thyroid or skin, 0.56 rem/week to bone, 0.1 rem/week to the gonads or total body, and 0.3 rem/week to other organs of the body. In this revised edition the period of occupational exposure is 50 years (it was formerly 70 years). The GI tract is the critical body organ for more than 50 per cent of the 230 radionuclides listed in these publications. All MPC values are calculated on the assumption that the body burden of the radionuclides is an exponential function of time. In addition, in the few cases where sufficient data are available, calculations are made on the basis of a power function of time. (auth)

16906

AEROSOL ACTIVITY FROM EXPERIMENTAL LOW POWER REACTOR OPERATION. P. R. Bolton, E. C. Barnes, E. D. Durkosh, and W. D. Small (Westinghouse Electric Corp., Pittsburgh). Health Phys. 1, 135-40 (1958) Sept.

The radioactive aerosol resulting from the low power critical operation of light water moderated experimental reactors has been studied. This phenomenon has been found in conjunction with plastic and unclad fuel elements. The activity found is attributed to several of the decay daughters of the noble gas fission products. It is characterized by an effective half-life of about 25 min and is interpreted to be of low toxicity. The authors suggest the use of exhaust ventilation or respirators when entering the critical assembly rooms after certain operations to keep the exposure to a minimum. (auth)

16907

POSSIBLE HEALTH HAZARDS ASSOCIATED WITH THE LAUNDERING OF RADIOACTIVELY CONTAMINATED PROTECTIVE CLOTHING. S. G. Pearsall and L. Gemmell (Brookhaven National Lab., Upton, N. Y.) and A. Breslin (U. S. Atomic Energy Commission New York). Health Phys. 1, 176-83(1958) Sept.

An engineering study was made at the Brookhaven National Laboratory to evaluate the possible health hazards to laundry personnel and the public connected with the operation of a decontamination laundry. Laboratory clothing was separated into eight groups, ranging from only slight amounts to rather large amounts of contamination. The groups contained from nineteen to thirty-one coveralls each, with all of the garments in the same group containing about the same amount of radioactive contamination. Each group was washed as a separate batch. Air samples were taken at various breathing zones and at various times during the operation to determine the air-borne dust hazard. The waste water was assayed for activity, the dryer effluent was monitored and the equipment, building, etc., were checked for contamination during the laundry operation of the eight groups. The data show that the greatest hazard lies in the inhalation of air-borne radioactive dusts. Washwater, laundry equipment, surfaces and floors became contaminated. Clean clothes showed cross contamination if washed with even slightly contaminated clothing. The dryer effluent was invariably contaminated with radioactive lint. It was evident that below 1 to 2 $\mu$c of contamination per garment, one could send radioactive clothing to a commercial laundry without hazard to the laundry operators or to the public. Higher levels can be handled safely by a commercial laundry if the loading and sorting operations are carefully managed. (auth)

16908

SOME GENERAL CONSIDERATIONS IN CHEMICAL DECONTAMINATION. P. J. Barry (Atomic Energy of Canada, Ltd., Chalk River, Ont.). Health Phys. 1, 184-8(1958) Sept.

The elementary principles involved in the removal of radioactive contamination from surfaces are discussed. The properties of the materials used in washing formulae and their use in freeing cotton from different forms of contamination are described. The role of detergents and sequestering agents in preventing re-contamination until the wash liquor is removed is discussed in terms of elementary chemical theory. (auth)

16909
MAXIMUM PERMISSIBLE RADIATION EXPOSURES TO MAN. L. S. Taylor (National Bureau of Standards, Washington). Health Phys. 1, 200-4(1958) Sept.

Basic rules and operational guides are outlined which were set forth by the National Committee on Radiation Protection and Measurements for use in the revision of handbooks on Maximum Permissible Radiation Exposures to man. (C.H.)

16910
BONE AND RADIOSTRONTIUM. Arne Engström, Rolf Björnerstedt, Carl-Johan Clemedson, and Arne Nelson. New York, John Wiley and Sons, Inc., 1958. 139p.

The morphology and physiology of bone are reviewed. The distribution of mineral salts in bone, and factors affecting the distribution of strontium-90 in the skeleton are discussed. The internal hazards from radiostrontium and the dose rate distribution from $\beta$-emitters was calculated. Data are tabulated. (C.H.)

16911
TECHNICAL INFORMATION BULLETIN ON ATOMIC WEAPON ACCIDENT HAZARDS, PRECAUTIONS AND PROCEDURES. Sept. 30, 1958. Washington, Atomic Energy Commission and Department of Defense, 1958. 6p. Available for free from Public Information Office, Atomic Energy Commission, Washington.

Unclassified information on safety precautions, potential health hazards, and procedures applicable at the scene of an accident involving atomic weapons is presented. (J.S.R.)

## Radiation Sickness

16912
ACUTE CLINICAL EFFECTS OF PENETRATING NUCLEAR RADIATION. Herbert B. Gerstner (School of Aviation Medicine, Randolph AFB, Texas). J. Am. Med. Assoc. 168, 381-8(1958) Sept. 27.

The clinical picture of acute radiation syndrome is described including its subdivisions, e.g., cerebral, gastrointestinal, and hematopoietic forms. Signs and symptoms are dependent on dose and individual susceptibility. The hematopoietic form of the disease will probably pose the major problem in radiation catastrophe. Some basic rules for medical radiation defense are derived from the typical time course of the hematopoietic form for the physicians use. (J.R.D.)

## Radiotherapy

16913
ARTIFICIAL RADIOISOTOPES IN THE DIAGNOSIS AND THERAPY OF BRAIN TUMORS. T. Riechert and F. Mundinger. Atombrief 4, 275-9(1958). (In German).

The use of short-lived radioisotopes in the diagnosis and treatment of brain tumors at the Neuro-Surgical University Clinic at Freiburg i. Br. is described. (J.S.R.)

## Toxicology Studies

*Refer also to abstract 16900.*

16914 AF-SAM-58-88
School of Aviation Medicine, Randolph AFB, Tex.
TOXICOLOGIC STUDIES WITH YTTRIUM NITRATE AND LANTHANUM NITRATE AS MODIFIED BY SITE OF INJECTION AND WHOLE-BODY RADIATION. Quentin L. Hartwig, Thomas P. Leffingwell, and George S. Melville, Jr. Mar. 4, 1958. 8p.

Yttrium and lanthanum, in the nitrate form, were administered by various avenues to rats, some of which had been subjected to whole-body irradiation by $Co^{60}$ gamma rays. Rats receiving intraperitoneal injections of yttrium nitrate plus whole-body exposure to ionizing radiation evidenced a higher mortality (significant to the 5 percent confidence level) than rats receiving either radiation or intraperitoneal injections of yttrium nitrate alone. Subcutaneous injection of 200 mg of yttrium or lanthanum nitrate caused abscess formation and subsequent epilation. No effect was noted when sodium nitrate or saline were similarly injected into rats. The presence of yttrium and lanthanum nitrates caused delayed healing of wounds. Similar effects were not produced when sodium nitrate was administered in the same manner. (auth)

16915
INVESTIGATIONS ON THE THERAPEUTIC POSSIBILITIES IN POISONING WITH RADIOACTIVE FISSION PRODUCTS. 2. THE EFFECT OF DIAMINDODIETHYLETHER TETRAACETIC ACID AND DIETHYLENETRIAMINE PENTAACETIC ACID ON THE DISTRIBUTION OF RADIOCERIUM. Alexander Catsch, Du Khuong Lẽ, and Helga Melchinger (Heiligenberg-Instituts, Germany). Strahlentherapie 106 606-26(1958). (In German)

The influence of diaminodiethylether tetraacetic acid and diethylenetriamine pentaacetic acid on the behavior of radiocerium was studied. Both substances show a very high efficiency in prophylactic, subsequent as well as in oral administration, and possess an adequately large therapeutic range, thus proving to be considerably superior to ethylenediamine tetraacetic acid. (auth)

## Tracer Applications

16916
DETERMINATION OF HEAVY WATER (HDO) IN BODY FLUIDS BY DIRECT INTRODUCTION OF WATER INTO A MASS SPECTROMETER; MEASUREMENT OF TOTAL BODY WATER. A. D. Wentzel, J. M. Iacono, T. H. Allen, and J. E. Roberts (Fitzsimons Army Hospital, Denver). Phys. in Med. and Biol. 3, 1-6(1958) July.

By directly introducing one microlitre of distillate of urine, blood serum, etc., into the sample reservoir of a mass spectrometer, it is possible to determine the ratio of HDO to $H_2O$ molecules in the vapor to within a standard deviation corresponding to 2%. Duplicate determinations can be performed in 5 minutes, not counting the time for distillation which is done in 30 minutes. A rigorous definition of total body water is developed in which attention is given to each appreciable factor required for accurately stating the final volume. (auth)

16917
TRACER METHODS FOR ESTIMATING TOTAL WATER EXCHANGE IN MAN. J. E. Roberts, K. D. Fisher, and T. H. Allen (Fitzsimons Army Hospital, Denver). Phys. in Med. and Biol. 3, 7-15(1958) July.

The exchange of body water is here analyzed mathematically in terms of the variables necessary to measure the inflow and outflow rates with water tracers. Four separate cases are discernible depending upon whether HDO or HTO is the tracer and whether the body water is or is not changing decidedly in volume. One of these cases was tested by giving $D_2O$ to six subjects who were placed on measured water intakes. The predicted water intake was ascertained from the decline in

daily levels of HDO activity. Predicted and measured intakes agreed within limits slightly exceeding the precision of tracer determinations; between 15 to 30 liters flow the $2\sigma$ accuracy was essentially 6%. A mathematical technique is presented for studying water exchange by tracers when the volume of the system is changing, e.g., during the development of dehydration or overhydration. (auth)

**16918**

EFFECTS OF AGE AND MODE OF INGESTION ON ABSORPTION OF PLUTONIUM. John E. Ballou (General Electric Co., Richland, Wash.). Proc. Soc. Exptl. Biol. Med. 98, 726-7(1958) Aug.-Sept.

The effect of age on gastrointestinal absorption of plutonium was determined for rats over the range 1 to 84 days of age. Absorption for 1-day-old rats was 85 times that reported for the adult. This dropped to near adult levels in the 21-day-old weanlings. Plutonium distribution in the 7-day-old rat was essentially the same as that found for the adult. Absorption of plutonium applied directly to the tongue or fed in drinking water did not differ significantly from absorption following gavage feeding. It was concluded that the hazard of ingested plutonium is not increased when exposure of the oral cavity and esophagus is involved. (auth)

**16919**

COMPARATIVE ULTRAFILTRATION OF CALCIUM AND STRONTIUM IN SERUM. Joseph Samachson and Hilda Lederer (Montefiore Hospital, New York). Proc. Soc. Exptl. Biol. Med. 98, 867-70(1958) Aug.-Sept.

Sera of patients and normal individuals have been ultrafiltered through cellophane to determine relative filterability of Sr and Ca, using $Sr^{85}$ and $Ca^{45}$ as tracers. In every case, Sr was found to filter more completely, values for 37.5° averaging close to 60% for Sr, and 40% for Ca, calculated on the basis of total serum filtered. None of several variables tested affected relative filterability of the 2 ions. Neither addition of stable Sr nor slight changes in pH, such as might result from manipulation during the experiment, produced significant changes in filterability. There appeared to be a slight negative temperature effect, values for both isotopes being lower at 37.5°C than at 23°C, although the effect on $Ca^{45}$ was usually negligible. Results indicate that Ca is more completely bound to protein than is Sr, more Sr remaining in a free form. (auth)

**16920**

UPTAKE OF WASTE $Sr^{90}$ AND $Cs^{137}$ BY SOIL AND VEGETATION. E. R. Graham (Univ. of Missouri, Columbia). Soil Sci. 86, No. 2, 91-7(1958) Aug.

In 1943 White Oak Lake was constructed to serve as a final settling basin for the low-level waste effluent from the present Oak Ridge National Laboratory. In 1955 the dam was opened and the lake drained slowly so as to leave the alluvial material which had settled to the bottom. Primary vegetation started to grow on the area in the spring of 1956 and by mid-June most of the area was covered. A survey was made of the uptake of strontium-90 and cesium-137 by this vegetation. Properties of the soil affecting plant uptake are discussed. (C.H.)

# CHEMISTRY

*Refer also to abstracts 17296, 17335, and 17941.*

**16921** AD-142731

Ansco Div., General Aniline and Film Corp., Binghamton, N. Y.

GAMMA-RAY INSENSITIVE EMULSION. Quarterly Report No. 5 [for] April 1, 1957–June 30, 1957. D. A. Nepela and H. F. Nitka. Appendix. D. A. Nepela. July 19, 1957. 29p. Contract DA36-039-sc-70172.

Reversal development without or with dye coupling second development or silver intensification followed by rebromination and subsequent dye coupling development are capable of yielding good acceptable positive images in the presence of undesired fogging gamma-ray dosages of 150 to 200 roentgens. A standard negative development technique would fail to discriminate light images from fog caused by gamma radiation of only a few roentgens. If subsequent printing of the transparency on high contrast printing stock (via an internegative or directly on autopositive material) is employed, still higher gamma dosages can be tolerated. The reversal development technique also results in an image of very low graininess, as opposed to normal negative development techniques with subsequent printing onto high contrast positive material. This technique has been established for Ansco Hypan Film (ASA Exposure Index 40 for daylight), without any visible loss in definition. The influence of developer dilution, developer retarders and developer temperature on the light to gamma speed ratio was also investigated. Among these factors developer dilution in conjunction with prolonged development appears to be the most promising approach for improving the light to gamma speed ratio. (auth)

**16922** AERE-C/R-2566

United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England.

THE POLONIUM CHEMISTRY PROJECT (AUGUST 1953–APRIL 1958). K. W. Bagnall, J. H. Freeman, D. S. Robertson, P. S. Robinson, and M. A. A. Stewart. July 1958. 19p. $0.54(BIS).

The chemistry of polonium, except for its separation from lead and its handling, is discussed. The preparation of the pure metal by sublimation on Ag foil is described. Data on 40 compounds are given. (T.R.H.)

**16923** CF-58-9-50

Oak Ridge National Lab., Tenn.

ELECTROLYSIS CELL FOR RECOMBINATION STUDIES. R. S. Culver. Sept. 18, 1958. 7p. Contract [W-7405-eng-26]. $1.80(ph OTS); $1.80(mf OTS).

A small, laboratory-sized loop was designed for steady-state radiolytic gas recombination studies. It consists of an electrolysis cell, which simulates the radiolytic gas formed in a reactor, and a bomb for containing slurry under test. The electrolysis capacity of the system is adequate for the study of slurries having recombination rates as high as 10 moles/hr/liter of slurry at the proposed slurry reactor operating conditions. (auth)

**16924** CRMet-788

Atomic Energy of Canada Ltd. Chalk River Project, Chalk River, Ont.

THE COHESIVE ENERGY OF URANIUM DIOXIDE AND THORIUM DIOXIDE. B. G. Childs. Aug. 1958. 26p. (AECL-680). $0.50(AECL).

Theoretical values have been calculated of the heats of formation of uranium dioxide and thorium dioxide on the assumption that the atomic binding forces in these solids are predominantly ionic in character. The good agreement found between the theoretical and observed values shows that the ionic model may, with care, be used in calculating the energies of defects in the uranium and thorium dioxide crystal structures. (auth)

**16925** HW-56090
General Electric Co. Hanford Atomic Products Operation, Richland, Wash.
INTERIM REPORT NO. 1 ON THE TURCO 4501 PROCESS FOR THE DECONTAMINATION OF CARBON STEEL. Lyle D. Perrigo, Jr. May 15, 1958. 8p. Contract W-31-109-Eng-52. $1.80(ph OTS); $1.80(mf OTS).

Steel coupons which had been exposed in the KER loop 1 mockup tube were used in the study. The procedure and results are discussed, and it is pointed out that the process offers promise of low corrosion loss and good decontamination. (J.R.D.)

**16926** ISC-943
Ames Lab., Ames, Iowa.
COMPLEX METAL HALIDES IN FUSED ALKALI NITRATES. Marlowe L. Iverson and F. R. Duke. Dec. 1957. 79p. Contract W-7405-eng-82. $2.25(OTS).

Solubility relationships and reaction kinetics using a mixture of alkali nitrates as solvent for inorganic salts were investigated. Association effects observed show that complex ions are formed between metal ions and halide ions. The rate studies suggest a mechanism for a dichromate–nitrate reaction. Solubility dependence on halide concentration is interpreted in terms of complex ion formation. (T.R.H.)

**16927** NAA-SR-Memo-1285
North American Aviation, Inc., [Downey, Calif.]
A PROPOSED PROGRAM FOR THE STUDY OF THE CHEMISTRY OF METAL–SALT SYSTEMS AT HIGH TEMPERATURE. Daniel Cubicciotti, Archie G. Buyers, Francis J. Keneshea, Jr., and Samuel J. Yosim. Feb. 23, 1955. Changed from OFFICIAL USE ONLY Sept. 9, 1958. 10p. $1.80(ph OTS); $1.80(mf OTS).

A program is outlined for a study of metal–salt solutions. Included are investigations of the equilibrium solubilities of certain metals in their salts, some of the properties of the solutions, and the mechanisms of exchange between a liquid metal phase and a fused salt phase. (auth)

**16928** NP-6949
Rensselaer Polytechnic Inst., Troy, N. Y.
MOLTEN CARBONATES: BIBLIOGRAPHY AND LITERATURE REVIEW FOR LITHIUM, SODIUM, AND POTASSIUM CARBONATES. Technical Report No. 1. Max R. Lorenz and George J. Janz. Sept. 1958. 77p. RPI Project No. 441.35. Contract Nonr-591-(10).

An assessment of the status of knowledge for three of the alkali metal carbonates is given. The high reactivity of molten carbonates and the subsequent experimental problems undoubtedly contribute, in part, to the rather limited data and the lack of quality in many instances for the work accomplished. Further research in almost all the areas is required to meet the need for fundamental information required to interpret physicochemical and electrochemical processes in molten carbonates. 96 references. (auth)

**16929** NYO-7444
New York Univ., New York.
JUNCTION POTENTIALS IN MOLTEN SALTS. Technical Progress Report. Benson R. Sundheim. Feb. 17, 1958. 5p. Contract AT(30-1)-1938. $1.80 (ph OTS); $1.80(mf OTS).

Two discussions of junction potentials in solutions of molten salts having an ion in common are presented. (W.L.H.)

**16930** AEC-tr-3217
SOLUBILITY OF LITHIUM IN ITS FUSED CHLORIDE SALT. S. Kerpachev and E. Jordan. Translated by the Oak Ridge National Lab. Library Staff from J. Phys. Chem. 14, 1495-7(1940). 5p.

The dependence of the carbon electrode potential on the concentration of lithium dissolved in its fused chloride salt was investigated. The procedure and apparatus used are described, and an equation for the dependence relationship is presented. (J.R.D.)

**16931** NP-tr-148
OXIDES. VI. THE OXIDES OF MANGANESE. A. Simon and F. Fehér. Translated for U.K.A.E.A. Atomic Energy Research Establishment from Z. Elektrochem. 38, 137-48(1932). 47p.

The temperature dependence of valency between manganese and oxygen is examined, and preparation of the oxides is described. Manganese heptoxide is used as the starting material for the isobaric decomposition, which is described along with properties of the decomposition products. In addition, the thermochemistry of the manganese oxides is discussed. (J.R.D.)

**16932** NP-tr-149
COBALT OXIDES. A. Baroni. Translated by S. Pease (U.K.A.E.A., Atomic Energy Research Establishment) from Gazz. chim. ital. 69, 488-90(1940). 10p.

Electron microscopy studies of the system $CoO-O_2$ revealed the existence of $CoO_2$. This fact was supported by stability considerations. The $CoO_2$ forms at the surface making it invisible to x-ray methods. (T.R.H.)

**16933** NP-tr-150
MANGANESE OXIDES. A. Baroni. Translated by S. Pease (U.K.A.E.A., Atomic Energy Research Establishment) from Gazz. chim. ital. 68, 478-83(1940). 8p.

The decomposition and formation of $MnO_2$ in vacuo and oxygen pressure, respectively, were studied by thermal, x-ray, and electron microscopy methods to establish whether definite compounds other than $Mn_2O_3$ and $Mn_3O_4$ exist between MnO and $MnO_2$. No such compounds were found, and the $Mn_9O_{17} \cdot 4H_2O$ and $Mn_9O_{14}$ previously reported were found to be $Mn_2O_3$. (T.R.H.)

**16934** NP-tr-155
IN SEARCH OF NEW KINDS OF FUEL. V. Kemskii (Kemskiy). Translated for Wright-Patterson Air Force Base, Ohio from Sovet. Aviatsiya, No. 79 (2943), p.2(1958). 70p. (F-TS-9502/III).

In the search for new kinds of high-calorific fuels for supersonic aircraft and long-range rockets, various sources of energy, conceivable within the framework of chemical and physical laws, are being studied. Compounds of hydrogen and boron are considered, as well as nuclear and solar engines. (W.D.M.)

**16935** SCL-T-198
STUDY OF THE ACTION OF CERTAIN DEACTIVATING AGENTS AND SPECIAL ANTIOXYGENS ON THE AGING AND COLORATION OF WHITE [RUBBER] MIXTURES. (Etude de l'action de Certains Desactiveurs et Antioxygenes Speciaux sur le Vieillissement et la Coloration des Melanges Blancs). Xavier Beau. Translated by Marcel Weinreich (Sandia Corp.) from Rev. gén. caoutchouc 31, 49-53(1954). 9p.

A number of new agents have been developed for the rubber industry which reduce the deterioration of rubber due to aging. These special antioxidants and their combinations with deactivating agents produce white and clear mixtures. The properties of some of these agents are discussed. (C.H.)

**16936**
THE SOLUBILITY OF ALUMINUM HYDROXIDE IN ACIDIC AND BASIC MEDIA AT 25°C. K. H. Gayer,

L. C. Thompson, and O. T. Zajicek (Wayne State Univ., Detroit, Mich.). Can. J. Chem. 36, 1268-71(1958) Sept.

The solubility of $Al(OH)_3$ was measured in NaOH and $HClO_4$ solutions. Possible reactions of $Al(OH)_3$ in dilute NaOH and $HClO_4$ solutions are indicated along with the calculated constants. The amphoteric hydroxide was found to be more acidic than basic. The isoelectric point of $Al(OH)_3$ was determined to be pH 7.7 (auth)

**16937**

THE ELECTROCHEMICAL BEHAVIOR OF ZIRCONIUM IN SULFURIC ACID. N. A. Balashova and B. N. Kabanov (Inst. of Electrical Chemistry, Academy of Sciences, USSR). Doklady Akad. Nauk S.S.S.R. 121, 126-8(1958) July 1. (In Russian)

The cathode and anode polarization behavior of zirconium in 1N $H_2SO_4$ and zirconium potential variations with delayed time in air, in sulfuric acid, and in bare electrode were investigated. (R.V.J.)

**16938**

THE EFFECT OF THE RADIOACTIVE $S^{35}$ RADIATION INTENSITY ON THE RATE OF ISOTOPIC EXCHANGE OF SULFUR IN THE $K_2SO_4-SO_3$ SYSTEM. V. I. Spitsyn and I. E. Mikhailenko (Lomonosov Moscow State Univ.). Doklady Akad. Nauk S.S.S.R. 121, 319-21 (1958) July 11. (In Russian)

Effects of $S^{35}$ $\beta$ radiation on the rate of isotopic exchange of sulfur between solid potassium sulfate were studied with labeled $S^{35}$ and sulfuric anhydride gas. Investigations were made under similar conditions at 840° with the $K_2SO_4$ preparations. (R.V.J.)

**16939**

THE ACTIVITY COEFFICIENTS OF ALKALI METAL NITRATES AND PERCHLORATES IN DILUTE AQUEOUS SOLUTIONS AT 25° FROM DIFFUSION COEFFICIENTS. Herbert S. Harned and Joseph A. Shropshire (Yale Univ., New Haven). J. Am. Chem. Soc. 80, 2967-8(1958).

The diffusion coefficients of lithium and cesium nitrates have been measured at 25° over a concentration range from 0.003 to 0.015 molar. From these data, the activity coefficients of these electrolytes have been computed at low concentrations. Similar calculations have been carried out for lithium and potassium perchlorates and potassium nitrate solutions and the results tabulated. (auth)

**16940**

CHEMICAL EFFECTS OF ATOMIC HYDROGEN IN AQUEOUS SOLUTIONS. Thomas W. Davis, Sheffield Gordon, and Edwin J. Hart (Argonne National Lab., Lemont, Ill.). J. Am. Chem. Soc. 80, 4487-91(1958) Sept. 5.

Evidence has been obtained for the oxidation of ferrous ions in sulfuric acid solution by hydrogen atoms. The hydrogen atoms were produced externally and circulated through the cell containing the ferrous ions. On the basis of these results and the non-chain character of the $\gamma$-ray induced water-deuterium reaction, the authors conclude that oxidation is not through $H_2^+$. Two mechanisms proposed are: $H + H^+ + Fe^{2+} = H_2 + Fe^{3+}$ and $H + Fe^{2+} \cdot (H_2O)_n = H_2 + Fe^{3+} \cdot (H_2O)_{n-1} + OH^-$. (auth)

**16941**

DECOMPOSITION OF DIBORANE IN A SILENT DISCHARGE. ISOLATION OF $B_8H_{10}$ AND $B_9H_{15}$. William V. Kotlensky and Riley Schaeffer (Iowa State Coll., Ames). J. Am. Chem. Soc. 80, 4517-19(1958) Sept. 5.

The decomposition of diborane in a silent discharge in the presence of an inert gas produces $B_4H_{10}$ in 40% yield, $B_5H_9$ in 20% yield, $B_5H_{11}$ in 30% yield and small amounts of $B_9H_{10}$ and a previously unidentified hydride, $B_9H_{15}$. This is the first new borane isolated since the work of Stock more than thirty years ago. A partial mass spectrum of $B_8H_{10}$ is presented. (auth)

**16942**

THE HEATS OF FORMATION AT 25° OF THE CRYSTALLINE HYDRIDES AND DEUTERIDES AND AQUEOUS HYDROXIDES OF LITHIUM, SODIUM AND POTASSIUM. Stuart R. Gunn and LeRoy G. Green (Univ. of California, Livermore). J. Am. Chem. Soc. 80, 4782-6(1958) Sept. 20.

The heats of reaction with water have been measured at 25° for lithium, sodium and potassium and for their hydrides and deuterides. The values determined, in kcal./mole, are: $M(c) + 1001\ H_2O(l) = MOH \cdot 1000H_2O + \frac{1}{2}H_2(g)$, $\Delta H^0_{Li} = -53.142 \pm 0.019$, $\Delta H^0_{Na} = -44.069 \pm 0.006$, $\Delta H^0_k = -46.900 \pm 0.010$; $MH(c) + 1001H_2O(l) = MOH \cdot 1000H_2O + H_2(g)$, $\Delta H^0_{Li} = -31.476 \pm 0.018$, $\Delta H^0_{Na} = -30.582 \pm 0.019$, $\Delta H^0_k = -33.081 \pm 0.005$; $MD(c) + 1001H_2O(l) = MOH \cdot 1000H_2O + HD(g)$, $\Delta H^0_{Li} = -31.321 \pm 0.007$, $\Delta H^0_{Na} = 30.693 \pm 0.004$, $\Delta H^0_k = -33.625 \pm 0.004$. The thermochemical crystal energies are calculated and compared with electrostatic crystal energies. (auth.)

**16943**

PRODUCTION OF CADMIUM SULFIDE CRYSTALS BY COEVAPORATION IN A VACUUM. R. J. Miller and C. H. Bachman (Syracuse Univ., N. Y.). J. Appl. Phys. 29, 1277-85(1958) Sept.

Apparatus was developed by which beams of cadmium and of sulfur were simultaneously directed to a common point on a temperature controlled substrate in a demountable vacuum apparatus. Cadmium sulfide crystals were obtained. The various types of crystals: spiroidals, globules, ribbons, and needles are described together with the conditions tending to produce each type. Crystal size can be increased by repeated exposure to the beams. (auth)

**16944**

PASSIVITY DURING THE OXIDATION OF SILICON AT ELEVATED TEMPERATURES. Carl Wagner (Massachusetts Inst. of Tech., Cambridge). J. Appl. Phys. 29, 1295-7(1958) Sept.

The dependence of the rate of the oxidation of silicon in oxygen-helium mixtures on gas composition at 1410°C is discussed theoretically. At low oxygen contents of the gas, no layer of solid silica is expected to occur and the rate of attack due to formation of volatile SiO is supposed to be proportional to the oxygen partial pressure in the bulk gas. Above a critical oxygen partial pressure, solid silica may be formed and the rate of attack under steady-state conditions may drop by several powers of ten. (auth)

**16945**

DISSOCIATION OF FORMIC ACID AND DEUTEROFORMIC ACIDS BY ION-MOLECULE COLLISION. C. E. Melton and Gus A. Ropp (Oak Ridge National Lab., Tenn.). J. Chem. Phys. 29, 400-5(1958) Aug.

The dissociation of 5.1 kev $HCOOH^+$, $DCOOH^+$, and $HCOOD^+$ ions by ion-molecule collision with $H_2$, $D_2$, He, $N_2$, A, and Kr has been investigated in a mass spectrometer. Approximate values for the cross sections for the resultant fragment ions have been calculated. Positive ion fragments $CHO^+$ and $CHO_2^+$ are produced by loss of hydrogen from both of the possible positions. However, rupture of the C-H bond is a factor of two more probable than cleavage of the O-H bond in the formation of $CHO_2^+$. The $CHO^+$ ion fmgment is formed mainly by removal of the hydroxyl group. (auth)

**16946**

THE SZILARD CHALMERS REACTION IN FERRICINIUM PICRATE. J. Jach and N. Sutin (Brookhaven National Lab., Upton, N. Y.). J. Inorg. & Nuclear Chem. 7, 5-7(1958) Aug.-Sept.

The products of the Szilard-Chalmers reaction in ferricinium picrate have been separated by solvent extraction. For samples irradiated in the center of the Brookhaven reactor about 2.4% of the $Fe^{59}$ activity was found in the form of parent compound and about 69 per cent as inorganic iron. The quantitative distribution of the $Fe^{59}$ was not altered by heating the irradiated crystals. An explanation of these results is offered in terms of the reactions undergone by the fragments produced in the solid during the irradiation and the nature of the crystal. (auth)

**16947**

PREPARATION AND PROPERTIES OF $LiAu(CN)_2$, $NaAu(CN)_2$, AND THE DOUBLE COMPOUND $LiAu(CN)_2 \cdot KAu(CN)_2$. R. A. Penneman and E. Staritzky (Los Alamos Scientific Lab., N. Mex.). J. Inorg. & Nuclear Chem. 7, 45-50(1958) Aug.-Sept.

Preparation and properties of $LiAu(CN)_2$, $NaAu(CN)_2$ and of the double compound $LiAu(CN)_2 \cdot KAu(CN)_2$ are presented. $LiAu(CN)_2$ is brilliant yellow and very water soluble (1.8 kg/l at 25°C); rhombohedral cell dimensions are: $a_0 = 8.934 \pm 0.005$ A, $\alpha = 21°48'$. $LiAu(CN)_2 \cdot KAu(CN)_2$ is colorless, tetragonal, with $a_0 = 7.1120 \pm 0.0006$ A, $c_0 = 8.5896 \pm 0.0006$ A. An equimolar solution of $LiAu(CN)_2$ and $KAu(CN)_2$ is incongruently saturated at 25°C, depositing, on isothermal evaporation, first $KAu(CN)_2$ and later $LiAu(CN)_2 \cdot KAu(CN)_2$. New values for the cell dimensions of $NaAu(CN)_2$ were determined. $NaAu(CN)_2$ is colorless, rhombohedral, with $a_0 = 9.24$ A, $\alpha = 22°42'$, calculated density, 4.38, measured 4.375. No compound formation or solid solution was observed between $LiAu(CN)_2$ and $NaAu(CN)_2$. (auth)

**16948**

PRELIMINARY STUDY ON THE KINETICS OF ISOTHERMAL ANNEALING OF RADIATION DAMAGE IN SZILARD-CHALMERS REACTION WITH $\alpha$-TRIS GLYCINE COBALT(III). A. Nath and S. B. Srivastava (Atomic Energy Establishment, Bombay). J. Inorg. & Nuclear Chem. 7, 143-4(1958) Aug.-Sept.

The annealing of the damage in neutron-irradiated compounds as a result of subsequent heating has been observed by several workers. The present investigations are a part of a comprehensive study of thermal annealing in cobalt complexes. The annealing in tris-glycine cobalt(III) is found to be characterized by three or more first-order rate processes. The results on a sample stored at about 4 to 5°C for several months show that the thermal history is profoundly reflected in the annealing behavior. (auth)

**16949**

THE KINETICS OF THE REACTION BETWEEN PLUTONIUM(VI) AND URANIUM(IV). T. W. Newton (Los Alamos Scientific Lab., N. Mex.). J. Phys. Chem. 62, 943-7(1958) Aug.

The kinetics of the reaction between Pu(VI) and U(IV) have been studied in perchlorate media. The hydrogen ion dependence indicates that the reacting system passes consecutively through two activated complexes with nearly the same $\Delta F^*$ values. The formulas and heats, free energies and entropies of formation of these complexes from the reactants were found to be: $(H_2O \cdot U \cdot OH \cdot OPuO)^{+5}$, $\Delta H^* = 17.6$ kcal/mole, $\Delta F^* = 16.6$ kcal/mole and $\Delta S^* = 3.4$ e.u., and for $(HO \cdot U \cdot OH \cdot OPuO)^{+4}$, $\Delta H^* = 21.4$ kcal/mole, $\Delta F^* = 16.0$ kcal/mole and $\Delta S^* = 18.1$ e.u. The relation between the kinetics of this reaction and the similar reactions between Np(IV) and Np(VI) and between Pu(IV) and Pu(VI) are discussed. (auth)

**16950**

THE VAPOR PRESSURES OF $BiBr_3$ OVER LIQUID $Bi-BiBr_3$ SOLUTIONS. Daniel Cubicciotti and F. J. Keneshea, Jr. (Stanford Research Inst., Menlo Park, Calif.). J. Phys. Chem. 62, 999-1002(1958) Aug.

The vapor pressures of $BiBr_3$ over mixtures of Bi with $BiBr_3$ were determined by the transpiration method as a function of Bi content in the range 300 to 400° and 0 to 0.6 in Bi mole fraction. The vapor was found to be essentially $BiBr_3$ over the range studied. The $BiBr_3$ activities showed positive deviations from Raoult's law. The relative partial molal enthalpies and entropies of $BiBr_3$ in the mixtures were positive for low Bi concentrations and decreased for higher concentrations. (auth)

**16951**

SOLUBILITY OF PENTAERYTHRITOL TETRANITRATE. Robert N. Roberts and Robert H. Dinegar (Los Alamos Scientific Lab., N. Mex.). J. Phys. Chem. 62, 1009-11 (1958) Aug.

The solubility of pentaerythritol tetranitrate (PETN) in acetone, aqueous acetone, ethyl alcohol, ethyl acetate, and benzene has been measured as a function of temperature. The data have been analyzed in terms of the equations of solutions relating the temperature coefficient of solubility with the heat of solution of the solute. The heat of fusion of PETN has been estimated from these experiments as 23 to 24 kcal mole. (auth)

**16952**

HOMOGENEOUS CATALYSIS FOR HOMOGENEOUS REACTORS. CATALYSIS OF THE REACTION BETWEEN HYDROGEN AND OXYGEN. H. F. McDuffie, E. L. Compere, H. H. Stone, L. F. Woo, and C. H. Secoy (Oak Ridge National Lab., Tenn.). J. Phys. Chem. 62, 1030-6(1958) Sept.

The reaction between hydrogen and oxygen, dissolved in aqueous solutions at elevated temperatures, is catalyzed homogeneously by dissolved cupric salts. The rate of consumption of hydrogen, $dy/dt$, is given by the equation $dy/dt = V_1(P/\alpha)[Cu^{++}]^{\frac{1}{2}}k_{Cu}$. When no vapor phase is present, or when there is no mass transfer of hydrogen to the liquid phase during the reaction, this equation reduces to $-d[H_2]/dt = [H_2][Cu^{++}]^{\frac{1}{2}}k_{Cu}$. The specific reaction rate constant for cupric perchlorate in dilute perchloric acid solution at 250° is 1.4 $M^{-1}$ $sec^{-1}$; for cupric sulfate in 0.16 M uranyl sulfate solution the specific reaction rate constant is given by the expression $k_{Cu} = 2 \times 10^{10} \exp(-24{,}140/RT)$ $M^{-1}$ $sec^{-1}$. (auth)

**16953**

INTERACTIONS OF METALS WITH THEIR MOLTEN SALTS. I. THE NICKEL-NICKEL CHLORIDE SYSTEM. J. W. Johnson, Daniel Cubicciotti, and C. M. Kelley (Stanford Research Inst., Menlo Park, Calif.). J. Phys. Chem. 62, 1107-9(1958) Sept.

Nickel metal has been found to have appreciable solubility in molten nickel chloride. The depression of the freezing point of nickel chloride (1009.1°) by the dissolved metal was measured and a eutectic point found at 977.5° and 9 mole % Ni. The constitution of the solution is discussed in the light of the freezing point depression. (auth)

**16954**

AGGREGATION OF SOME OF THE AMINE EXTRACTANT SPECIES IN BENZENE. Kenneth A. Allen (Oak

Ridge National Lab., Tenn.). J. Phys. Chem. 62, 1119-23(1958) Sept.

In light scattering measurements at 546 mμ the normal sulfates of tri-n-octylamine, di-1-isobutyl-3,5-dimethylhexylamine, methyldi-n-octylamine, 1,3-ethylpentyl-4-ethyloctylamine, and di-n-decylamine showed aggregation numbers of 1, 4, 9, 11, and 38, respectively, in benzene solution. Tri-n-octylamine bisulfate is dimeric. The linear dependences on concentration of the 90°/0° scattering ratios indicated that these solutes were monodisperse. The uranyl sulfate complexes of these amine sulfates were all monomeric except that of the primary amine, which appeared to be a dimer. The monomeric natures of tri-n-octylamine sulfate and of the di-n-decylamine sulfate–uranyl sulfate complex were confirmed by isopiestic and viscosimetric measurements. (auth)

**16955**

ON THE POMERANCHUK EFFECT THEORY IN $He^3$. D. G. Sanikidze (Kharkov State Univ.). Zhur. Eksptl'. i Teoret. Fiz. 35, 279-80(1958) July. (In Russian)

The Pomeranchuk theory predicted the minimum of the $He^3$ melting curve to be on the P-T diagram; below the melting heat the minimum should be negative. Thermodynamic functions calculated on the Fermi-liquid model are used in the investigation of the effect. The left branch of the melting curve is plotted on the known portion of the curve above the minimum. (R.V.J.)

## Analytical Procedures

**16956** AERE-C/M-327

United Kingdom Atomic Energy Authority. Research Group. Chemistry Div., Woolwich Outstation, England.

A STUDY OF THE ACCURACY AND PRECISION OF THE LANTHANUM FLUORIDE COPRECIPITATION METHOD FOR THE DETERMINATION OF PLUTONIUM. R. B. Chenley, G. J. Hunter, and T. J. Webber. June 1958. 15p. $0.32(BIS).

The values of accuracy and precision claimed for the lanthanum fluoride coprecipitation method by other workers have been reviewed. The accuracy and precision of the procedure used have been determined, and consideration has been given to the choice of a standard of reference for the accuracy. When comparison was made on a mass basis the accuracy based on seventy determinations by several operators was 97.4%. The coefficient of variation of these determinations was 1.9%, which enables a correction to be made for the negative bias of the method with confidence. (auth)

**16957** AERE-C/R-2612

United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England.

IMPROVED ANALYTICAL METHODS OF SEPARATING LEAD. G. W. C. Milner, J. W. Edwards, and A. Paddon. July 1958. 8p. $0.32(BIS).

Ion exchange and solvent extraction methods were investigated for the separation of lead in the analysis of lead-base materials. Lead can be held on a column of Deacidite FF from 2M HBr solutions, and this has been used in the analysis of lead for alloying amounts (0.025 to 9%) of thorium. The thorium in the eluate is determined by titration with EDTA to the xylenol orange end point in the pH range 2.5 to 3. Very small amounts are determined absorptiometrically by the thoronol method. In a solvent extraction method for this separation, a 0.1 to 1 N acid solution of the sample is shaken with a solution of diethylammonium diethyldithiocarbamate in trichloroethylene before titration of the aqueous solution with EDTA or completion of the thorium determination with thoronol. (auth)

**16958** AF-SAM-58-93

School of Aviation Medicine, Randolph AFB, Tex. and Texas. Univ., Austin.

A SEMI-MICROTECHNIC FOR IRON-59 DETERMINATIONS IN BIOLOGIC SYSTEMS, USING BETA COUNTING IN A LIQUID SCINTILLATOR. Thomas P. Leffingwell, George S. Melville, Jr., and Robert W. Riess. Mar. 28, 1958. 6p.

After acid digestion of iron-containing components of biologic systems, the iron may be selectively complexed and extracted from the digestant solution. The colored complex is of adequate stability to permit spectrophotometric measurement of the total iron present. If iron-59 is present in the system, the same colored complex may be introduced into a liquid scintillator solution and the beta emanations counted with an efficiency approximating 50 percent. The technic offers approximately 25-fold increase in effective counting as compared to the commonly used gamma-counting technic, and up to a 15-fold reduction in initial sample size. (auth)

**16959**

ATOMIC-ABSORPTION SPECTROPHOTOMETRY WITH SPECIAL REFERENCE TO THE DETERMINATION OF MAGNESIUM. J. E. Allan (Dept. of Agriculture, Hamilton, New Zealand). Analyst 83, 466-71(1958) Aug.

The determination of magnesium by atomic absorption is examined in detail. The apparatus and method are described, and the results are discussed with regard to reproducibility, accuracy and sensitivity. It is shown that, by this method, reliable magnesium determinations can be made with the same ease and rapidity as flame-photometric determinations of sodium and potassium. (auth)

**16960**

THE POLAROGRAPHIC DETERMINATION OF THALLIUM, IRON AND COPPER IN HIGH-PURITY CADMIUM METAL. R. Carson (Rhoanglo Mine Services Ltd., Kitwe, Northern Rhodesia). Analyst 83, 472-6(1958) Aug.

A polarographic technique is described by which traces of thallium and iron can be co-determined, after extraction of the trichlorides, in essentially the same base electrolyte. Copper does not interfere at the concentrations under consideration and is separately determined by an extraction procedure with sodium diethyldithiocarbamate. An alternative polarographic procedure is described for the determination of copper, in which an ammonium chloride–ammonium hydroxide base electrolyte is used. (auth)

**16961**

THE COLORIMETRIC DETERMINATION OF THALLIUM IN TIN–CADMIUM ALLOYS. J. F. Woolley (Standard Telephones & Cables, Ltd., Harlow, Essex, Eng.). Analyst 83, 477-9(1958) Aug.

A colorimetric method is described for the determination of thallium in tin–cadmium alloys. Microgram amounts over the range 5 to 80 ppm can be determined with an error of ±2 ppm. (auth)

**16962**

THE ROUTINE ASSAY OF TRITIUM IN WATER AND LABELLED SUBSTANCES IN THE RANGE 20 TO $10^4$ μμc. P. R. Payne and J. Done (National Inst. for Medical Research, London). Phys. in Med. and Biol. 3, 16-26(1958) July.

A method is described in detail for the determination of radioactive hydrogen in a proportional gas counter. The conditions for the best operation of the counter are described. The apparatus, which has been in use for eight years, is easy to operate and requires very little maintenance. The gas filling for the counter is produced by the reaction of active water on aluminum carbide in a simple metal vessel, and this is extended to the assay of tritium in labelled compounds, by a procedure consisting of a preliminary combustion in a high pressure oxygen bomb followed by the reaction of the water produced with aluminum carbide. The whole procedure takes less than one hour, and any required number of samples can be prepared at the same time. The method is accurate to at least ±1% over the range of activities 20 to $10^4$ $\mu\mu$c. (auth)

**16963**

DETERMINATION OF GASES IN STEEL BY VACUUM FUSION—MASS SPECTROMETRY. J. F. Martin, J. E. Friedline, L. M. Melnick, and G. E. Pellissier (U. S. Steel Corp., Monroeville, Penna.). Trans. Met. Soc. AIME 212, 514-19(1958) Aug.

A method has been developed for determining gases in steel in which the gases are extracted by vacuum fusion and analyzed by mass spectrometry. This method is especially applicable for determining small amounts of oxygen and nitrogen. The lower limit of detection for both oxygen and nitrogen is 0.0001% with an average deviation of about 0.0001% for oxygen and 0.00008% for nitrogen. Hydrogen analyses by this method are in good agreement with analyses by vacuum tin-fusion. A complete analysis of all gases extracted from a steel sample can be accomplished in 40 min. (auth)

**16964**

DETERMINATION OF ZIRCONIUM BY AMPEROMETRIC TITRATION BY APPLICATION OF CUPFERRON. Yu. I. Usatenko and G. Ye. Bekleshova. Zavodskaya Lab. 23, 1406-7(1957).

A method for the determination of zirconium by amperometric titration with the addition of cupferron is described. A zirconium dioxide solution was used for the determination. The presence of aluminum, chromium, manganese, zinc, and nickel does not interfere with the determination. Titanium, pentavalent vanadium, oxidizing substances, or regenerators which produce anode diffusion currents interfere. The results are tabulated. (J.S.R.)

**16965**

COLORIMETRIC DETERMINATION OF ZIRCONIUM WITH "PHENYL-FLUORON". F. G. Zharovskiy and A. T. Philipenko. Zavodskaya Lab. 23, 1407-10(1957).

A method for the colorimetric determination of zirconium with phenylfluoron (2,3,7-trioxide-9-phenyl-6-fluoron) is described. Zirconium forms a light red compound with its maximum light absorption at 535 m$\mu$. The compound is soluble in ethanol, butanol, methyl ethyl ketone, isoamyl alcohol, butyl formate, and cyclohexanol. The ions which interfere with the determination are listed. The method can be adapted for the determination of zirconium in magnesium or aluminum. (J.S.R.)

## Crystallography and Crystal Structure

*Refer also to abstracts 17148 and 17307.*

**16966** CF-58-8-81

Oak Ridge National Lab., Tenn.

FACTORS INFLUENCING THE SIZES AND SHAPES OF CRYSTALS FORMED DURING THERMAL GRADIENT MASS TRANSFER. J. W. Prados and J. L. Scott. Aug. 22, 1958. 27p. Contract [W-7405-eng-26]. $4.80 (ph OTS); $2.70(mf OTS).

The differences in the sizes and shapes of crystals formed during four common types of thermal gradient mass transfer experiment are discussed. These differences are illustrated with photographs for each case considered. A mechanism is advanced to account for the variations in size of crystals between the various types of mass transfer experiment. Based on an idealized crystal model, equations are developed for predicting the limiting sizes and shapes of crystals which would be stable under various experimental conditions. Numerical computations for a specific system are presented in graphical form. (auth)

**16967**

THE STRUCTURE OF TETRAGONAL BORON. J. L. Hoard, R. E. Hughes, and D. E. Sands (Cornell Univ., Ithaca, N. Y.). J. Am. Chem. Soc. 80, 4507-15(1958) Sept. 5.

The fifty boron atoms of the tetragonal unit are divided among four approximately regular icosahedra centered in the positions ¼ ¼ ¼, ¾ ¾ ¼, ¾ ¼ ¾, ¼ ¾ ¾ of $P4_2/nnm$ with two individual atoms in 2b: 00 ½, ½ ½ 0. Each boron atom of an icosahedron forms six bonds directed toward the corners of a pentagonal pyramid, five within the same icosahedron, the sixth to an adjacent icosahedron or to an atom in 2b. The resulting framework is continuous in three dimensions. Typical intra- and intericosahedral bond distances are, respectively, 1.805 ± 0.015 and 1.68 ± 0.03 A. Available single crystals of tetragonal boron are subject to a large and variable degree of internal disorder: the diffraction data afforded by different specimens are notably diverse as regards strength of diffuse scattering, distribution of Bragg intensities, and lattice constants. Typical values of lattice constants are a = 8.75, c = 5.06 A. (auth)

**16968**

AN X-RAY STUDY OF TITANIUM TRIBROMIDE. Robert F. Rolsten and Harry H. Sisler (Ohio State Univ., Columbus). J. Phys. Chem. 62, 1024(1958) Aug.

That titanium tribromide crystallizes in two forms, platelet and needle. Only the platelet form was considered in detail. Preliminary work with the needle form indicates the crystal to be hexagonal, although different from the platelet form. The x-ray diffraction data for the platelet form of $TiBr_3$ can be indexed with the unit rhombohedral cell being $a_0 = 7.26_3$ A and alpha = 52°48′. An x-ray density of 4.24 g $cc^{-1}$ was calculated with two formula weights per unit cell. The space group is $C_{3i}^2-R_3$ and the structure is a layer lattice. The powder diffraction patterns for platelet $TiCl_3$ and platelet $TiBr_3$ have been compared. The observed spacings for the two compounds are slightly different as evidenced from the reported cell constants. Even so, the two compounds can be considered to be isostructural, since the spacings with corresponding Miller indices are in excellent intensity accordance. (auth)

**16969**

STRUCTURE OF EPITAXED COPPER DEPOSITED BY EVAPORATION ONTO A CLEAN (00·1) FACE OF A TITANIUM CRYSTAL. R. E. Schlier and H. E. Farnsworth (Brown Univ., Providence). Phys. and Chem. Solids 6, 271-6(1958) Aug.

The titanium crystal was cleaned by heating, ion-bombardment, and annealing in high vacuum. Low-energy electron diffraction was used to determine that the sur-

face was essentially free of contamination and to make structure determinations. The copper deposits varied in average thickness from 0·5 to 25 atomic layers. The copper formed at nucleation centers in the form of discrete oriented crystallites with a lattice spacing parallel to the substrate which was the same as that of the (111) plane in bulk copper, and with the (110) azimuth of copper parallel to the (11·0) azimuth of titanium. No variation of lattice spacing with thickness was detected. Deposition of copper on a titanium surface, covered with a chemisorbed layer of oxygen, resulted in the formation of disoriented deposits at nucleation centers. (auth)

**16970**

STRENGTH OF LITHIUM FLUORIDE WHISKERS. Gerald W. Sears (General Electric Research Lab., Schenectady, N. Y.). Phys. and Chem. Solids 6, 300-1 (1958) Aug.

A procedure is described for growing lithium fluoride whiskers. Stress/strain curves in tension were measured on a few lithium fluoride whiskers using a tensile machine. Mechanical properties of the whiskers closely approximate theoretical predictions for perfect crystals. Implications of results on studies of crystal structure of lithium fluoride crystals are discussed. (C.H.)

## Deuterium and Deuterium Compounds

*Refer to abstract 17331.*

## Fluorine and Fluorine Compounds

**16971**

OSMIUM HEXAFLUORIDE AND ITS IDENTITY WITH THE PREVIOUSLY REPORTED OCTAFLUORIDE. Bernard Weinstock and John G. Malm (Argonne National Lab., Lemont, Ill.). J. Am. Chem. Soc. 80, 4466-8 (1958) Sept. 5.

The reaction between osmium metal and fluorine gas had been reported in 1913 by Ruff and Tschirch to yield three products, $OsF_4$, $OsF_6$, and $OsF_8$. A repetition of their synthesis led to the formation of only the most volatile of these, the yellow solid that they identified as osmium octafluoride. Our measurements of the melting point, 32.1°, and the boiling point, 45.9°, establish the identity of the product with their octafluoride. However, the molecular weight determinations and chemical analysis show the composition of this compound to be $OsF_6$ rather than $OsF_8$. This conclusion is also supported by x-ray diffraction measurements and infrared and Raman spectroscopy. It appears very likely that the compound known now for many years as osmium octafluoride is in fact osmium hexafluoride and that the compound previously called $OsF_6$ also was identified incorrectly. (auth)

**16972**

VISCOSITIES AND SURFACE TENSIONS OF SOME LIQUID HALOGEN FLUORIDES. Max T. Rogers and Emerson E. Garver (Michigan State Univ., East Lansing). J. Phys. Chem. 62, 952-4(1958) Aug.

Values of the surface tension and viscosity of iodine pentafluoride, bromine pentafluoride and bromine trifluoride have been measured in the liquid phase over a range of temperature with a precision of ±2% and the data have been fitted to empirical equations. By application of the Eyring theory of viscosity the heats and free energies of activation for viscous flow have been computed and are compared with the energies of vaporization. These results, along with the Trouton constants and the dielectric constants, indicate that iodine pentafluoride and bromine trifluoride are associated in the liquid phase, whereas chlorine trifluoride and bromine pentafluoride probably are normal. (auth)

**16973**

FLUOROCARBON SOLUTIONS AT LOW TEMPERATURES. III. PHASE EQUILIBRIA AND VOLUME CHANGES IN THE $CH_4$–$CF_4$ SYSTEM. Ian M. Croll and Robert L. Scott (Univ. of California, Los Angeles). J. Phys. Chem. 62, 954-7(1958) Aug.

Liquid-liquid and liquid-solid phase equilibria in the system methane–perfluoromethane have been studied and the phase diagram constructed. The critical solution temperature is 94.5°K, at a critical mole fraction of $CF_4$ of approximately 0.43; these values are consistent with the free energies of mixing previously reported by Thorp and Scott. The eutectic temperature is 84.5°K at x = 0.88. The volume change on mixing $CH_4$ and $CF_4$ has been measured dilatometrically at 107°K. At $x = \frac{1}{2}$ the volume change is 0.88 $cm^3$ per mole or 2.1%. This is smaller than the values observed for fluorocarbon–hydrocarbon mixtures at room temperature (ca 5 $cm^3$ per mole); when allowance is made for the smaller excess free energy and the small coefficient of thermal expansion of $CF_4$, the whole series fits together consistently. (auth)

**16974**

PHYSICAL PROPERTIES OF n-PERFLUOROBUTANE. James A. Brown and Whitney H. Mears (Allied Chemical Corp., Morristown, N. J.). J. Phys. Chem. 62, 960-2 (1958) Aug.

A Martin–Hou equation of state has been obtained for n-perfluorobutane applicable to 800 p.s.i.a., 170° and to a molar volume of 0.38 l/g mole. Vapor pressure and densities of liquid and saturated vapor were determined from −40 to 113.2°, the measured critical temperature. From this information the rectilinear diameter line and the heats of vaporization have been computed. (auth)

**16975**

ELECTROLYTE EFFECTS ON NUCLEAR MAGNETIC RESONANCE FREQUENCIES OF FLUORINE IN AQUEOUS SOLUTIONS. Robert E. Connick and Richard E. Poulson (Univ. of California, Berkeley). J. Phys. Chem. 62, 1002-4(1958) Aug.

Observations have been made of the effect of several ions on the chemical shift of $F^{19}$ in the species $AlF^{++}$, $AlF_2^+$, and $F^-$ in aqueous solutions. The effects are determined primarily by the added positive ions. Potassium and sodium ions exhibit a remarkable difference at low concentrations in that their effects are of opposite sign. Possible explanations for the observations are discussed. (auth)

## Graphite

*Refer also to abstracts 17310, 17336, 17354, 17422, and 17945.*

**16976** AERE-M/R-2603

United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England.

CALCULATIONS ON THE RELEASE OF STORED ENERGY IN GRAPHITE. D. E. Rimmer and W. M. Lomer. June 1958. 21p.

This report indicates how to perform certain calculations on the release of stored energy in graphite, the results of which have been used during preparations for a Wigner Energy Release in BEPO. (auth)

16977 NAA-SR-Memo-1240
North American Aviation, Inc., [Downey, Calif.]
GRAPHITE OUTGASSING. R. R. Eggleston, R. L. Carter, W. J. Greening, and R. E. Durand. Jan. 21, 1955. Changed from OFFICIAL USE ONLY Sept. 9, 1958. 14p. $3.30(ph OTS); $2.40(mf OTS).

The amounts and composition of the gas evolved from various types of graphite under SRE operating conditions were determined. The information is of importance in design of SRE Zr moderator cans because of possible pressure build-up in the cans or the deleterious effects of the gas on the mechanical properties of Zr. Gas realisorption is discussed, along with results of gas analysis, emphasizing the implications of the gases found by analysis. (J.R.D.)

16978 WAL-371/48
Watertown Arsenal Lab., Mass.
ZIRCONIUM AND BORON CARBIDE COATINGS FOR GRAPHITE. H. B. Nudelman. June 1957. 23p. DA Project No. 5U17-01-002. (AD-138620).

The object of this investigation was to improve the elevated temperature oxidation resistance of graphite for rocket nozzle applications through the use of protective coatings. Experimental coatings based on zirconium and boron carbides were investigated. In general, coatings were applied by heating graphite in the presence of the coating material under an inert atmosphere. Elevated temperature oxidation resistance was evaluated by means of a laboratory flame-test apparatus. Other coating properties were studied by metallographic and x-ray diffraction techniques. Boron carbide coatings proved to be adherent, and markedly improved the oxidation resistance of graphite as determined by Laboratory flame tests. Zirconium coatings, while providing an increase in oxidation resistance, did not adhere to graphite in a satisfactory manner. (auth)

16979
POTENTIAL ENERGY FUNCTIONS FOR GRAPHITE. A. D. Crowell (Univ. of Vermont, Burlington). J. Chem. Phys. 29, 446-7(1958) Aug.

In using a (6-12) potential or a (6-exp) potential with graphite, it is reasonable to use the KM formula for the attractive potential constant as far as graphite is concerned. The values found for the repulsive potential constants will make it possible to use better values for the repulsive functions in energy calculations with graphite than have been employed. (auth)

16980
ON THE FORMATION OF THE RHOMBOHEDRAL GRAPHITE MODIFICATION. F. Laves and Y. Baskin (Univ. of Chicago). Z. Krist. 107, No. 5-6, 337-56(1956).

The stability relations between the hexagonal and rhombohedral graphite modification have been investigated using predominantly single crystals. Neglecting small amounts of stacking disorder, natural graphite crystals have been found to consist usually of the pure hexagonal modification. However, several examples were found to contain up to approximately 5% of rhombohedral modification. Rhombohedral modification could be produced in pure hexagonal graphite single crystals by unidirectional pressure associated with some shear. Several experimental procedures have been used in order to separate the influence of different factors that might be thought to be of importance for the formation of the rhombohedral modification. Studies were made on the influence of hydrostatic pressure, unidirectional pressure without gliding, gliding under application of as small a pressure as possible, mechanical twinning. In discussing the results of these experiments a process of "mechanical transformation" can be suggested that is closely related to processes of "mechanical twinning." Relative movements of $a\sqrt{3}/3$ (equal to the carbon-carbon distance) between fixed carbon double nets in the direction of the carbon-carbon bonds are involved in the process suggested. Thus, s (amount of macroscopical shear) = 0.21. Heat treatment at and above 1300°C reverts the rhombohedral modification to the hexagonal one. Application of hydrostatic pressure up to 10.000 Atm. did not change the ratio of hexagonal to rhombohedral modification in the single crystals. X-ray powder diagrams taken at room temperature under approximately 8.000 atm. showed that the hexagonal modification did not invert to the rhombohedral modification under these conditions. Therefore, it is concluded that the rhombohedral modification is metastable against the hexagonal one in essential agreement with the results of Boehm and Hofmann (1955) who approached the problem independently in a different manner. (auth)

## Laboratories and Equipment

*Refer also to abstracts 17071, 17319, and 17939.*

16981 AERE-E/M-63
United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England.
A DESIGN OF AIR EJECTOR FOR USE IN RADIOACTIVE LABORATORIES. J. R. Catlin and L. D. G. Coward. Nov. 1952. Decl. Mar. 1958. 9p. $0.32(BIS).

A design is evolved for the economic manufacture of a vacuum ejector to produce 25.3 in. of Hg vacuum, for use in lieu of water/air ejectors where the production of effluent such as in radiochemical laboratories may be a disadvantage. (auth)

16982 CF-58-2-110
Oak Ridge National Lab., Tenn.
A PORTABLE BANDSAW FOR HOT CELL USE. A. A. Abbatiello. Feb. 19, 1958. 9p. Contract [W-7405-eng-26]. $1.80(ph OTS); $1.80(mf OTS).

A commercial light-weight portable bandsaw was fitted with a grip to permit it to be maneuvered remotely in a hot cell by means of a General Mills manipulator. The bandsaw was supported in various positions to make cuts on typical pieces. Photographs show the saw in operation. (auth)

## Radiation Chemistry

*Refer also to abstracts 17372 and 17373.*

16983 AEC-tr-3389
SENSIBILIZATION OF THE RADIOLYTIC CONVERSION OF SODIUM NITRATE IN AQUEOUS ALKALINE SOLUTIONS. V. A. Sharpati (Sharpaty), V. D. Oreklov, and M. A. Proskurnin. Translated for Oak Ridge National Lab. from Collection "Action of the Ionizing Radiation on the Inorganic and Organic Systems," (p.37-42). Academy of Sciences U.S.S.R., Moscow, 1958. 9p.

The effect of solution temperature on the radiolytic reduction of nitrate in aqueous solution and on the same process sensibilized by addition of glycerine were investigated. The nitrate yield increases with temperature, and the sensibilizing effect of glycerine is manifested only when its concentration is above $5 \times 10^{-4}$M. (J.R.D.)

16984
RADIATION CHEMISTRY OF SOLUTIONS. II. DOSE-

RATE, ENERGY, AND TEMPERATURE DEPENDENCE OF A LEUCO TRIARYLMETHANE DOSIMETER SOLUTION. W. A. Armstrong and G. A. Grant (Defence Research Chemical Labs., Ottawa). Can. J. Chem. 36, 1398-1404(1958) Oct.

The dose-rate, energy, and temperature dependence of the system $10^{-4}$ M 4,4'-(5-chloro-2-thenylidene)bis [N,N-dimethylaniline], $10^{-4}$ M ferrous ammonium sulfate, 0.1 M sodium chloride, and $7 \times 10^{-3}$ M hydrochloric acid has been investigated. No energy dependence was observed in the range 0.16 to 2.0 Mev and no dose-rate dependence was observed in the range 4 to 230 rads/minute. However, with dose rates of 400 to 1200 rads/minute, postirradiation dye fading was observed. In the dosage range 0 to 1000 rads this fading is not extremely serious. The system is slightly temperature dependent at temperatures lower than 30°C and markedly dependent at higher temperatures. Dye yields of samples irradiated at 30°C were 10% higher than those of samples irradiated at 15° but 33% lower than those of samples irradiated at 45°. (auth)

**16985**

RADIATION INDUCED DECOMPOSITION OF LEAD NITRATE. Everett R. Johnson (Stevens Inst. of Tech., Hoboken, N. J.). J. Am. Chem. Soc. 80, 4460-2(1958) Sept. 5.

Lead nitrate decomposes under $\gamma$ radiation to yield nitrite ion and oxygen in the stoichiometric ratio 1:1. As the radiation proceeds the yield of oxygen appears to fall off to a steady-state ratio of 2:1. The yield of nitrite ion is decreased by heating at 60° but not the oxygen yield. (auth)

**16986**

PRODUCTS OF THE RADIOLYSIS OF WATER CONTAINING BENZENE AND AIR. Jerome Goodman and Joseph Steigman (Polytechnic Inst. of Brooklyn, N. Y.). J. Phys. Chem. 62, 1020-2(1958) Aug.

In the high-energy irradiation of water saturated with benzene and containing dissolved air, phenol and hydrogen peroxide are formed until oxygen is depleted. Phenol is then produced at a reduced rate, and biphenyl appears in increasing yield. Reported values for molecules of phenol formed per 100 ev absorbed vary from 1.32 to 3.05 with most values falling between 2.2 and 2.7. Results are tabulated. (auth)

**16987**

RADIOCHEMICAL POLYMERIZATION OF ACRYLONITRILE. SOME OBSERVATIONS ON THE AFTER-EFFECT. R. Bensasson and A. Bernas (Laboratorie de Chimie Physique, Paris). J. Polymer Sci. 30, 163-73 (1958) July. (In French)

Experiments with the $Co^{60}$ $\gamma$-ray irradiation (4 r/mn < I < 400 r/mn) of monomer/acrylonitrile, which gives a very pronounced after-effect when the polymerization is carried out in a precipitating medium are described. The reaction, during and after irradiation, was followed dilatometrically at 20°C, except for the evaluation of the activation energies. The following results were obtained: The rate decreases continuously with the time. At 20°C its initial value apparently does not depend on the yield of the radioconversion, and seems equivalent to the total rate of radiopolymerization. The degree of post-polymerization at a given time increases with the amount of polymer formed during the irradiation. The over-all activation energy of the radiopolymerization apparently varies with the temperature. If the radiopolymerization is carried out at 20°C and the post-effect observed at 40, 50, and 60°C, the activation energy with respect to the initial rates seems very high (about 35 kcal/mole). If the behavior in dimethylformamide is compared for polyacrylonitrile $P_1$, for which no post-effect was observed, with that of polyacrylonitrile $P_2$, which has been submitted to a post-polymerization, one observes: (1) that $P_2$ is less soluble than $P_1$; (2) that $P_2$ corresponds to a lower limiting viscosity number than $P_1$ and that the slope of the straight line $\eta_{sp}/c = [\eta] + [\eta]Kc$ is higher for $P_2$ than for $P_1$. These last observations suggest that the post-polymerization leads to the formation of branched polymers. (auth)

**16988**

DEGRADATION OF POLYSTYRENE IN DILUTE AERATED SOLUTION UNDER THE INFLUENCE OF GAMMA RADIATION. Jean Durup (Laboratoire de Chimie Physique, Paris). J. Polymer Sci. 30, 533-6 (1958) July. (In French)

The degradation of polystyrene in chloroform solution under the influence of $\gamma$-rays in the presence of air has been studied by a viscometric method. The kinetic analysis of the degradation velocity during and after irradiation indicates an oxidative degradation scheme, in which two parallel processes occur with two intermediates, one of a short life-time (oxygenated radical), the other relatively stable at ordinary temperatures (hydroperoxide). The results of irradiation of polystyrene in other solvents are discussed in terms of this mechanism. (auth)

**16989**

EFFECT OF GAMMA-RADIATION FERRIPROTOPORPHYRIN. Mary-Louise Rothschild, Laura Cosi, and Lawrence S. Myers, Jr. (Univ. of California, Los Angeles). Nature 182, 316(1958) Aug. 2.

Irradiation of an aqueous solution of ferriprotoporphyrin in 0.1 N sodium hydroxide with 15,000 r of gamma radiation from a cobalt-60 source results in a shift of the visable absorption spectra which is interpreted as indicating the formation of a compound with an intact porphyrin ring, followed by reactions resulting in a rupture of the porphyrin ring structure. Observations are reported in detail. (C.H.)

**16990**

USE OF ATOMIC ENERGY IN PROCESSES OF PETROLEUM TREATMENT. G. M. Panchenkov. Sbornik Primenen. radioakt. izotop. i izluchen. v neft. prom., Moscow Gostoptekhizdat. 100-8(1957). (Translated from Referat. Zhur. Khim. No. 1, 1958, Abstract No. 2513)

A review is presented of work on the effects of radiation on different conversion reactions of hydrocarbons which occur during processing of petroleum. The use of tagged atoms in the study of the mechanism of conversion of hydrocarbons is also discussed. (J.S.R.)

## Radiation Effects

*Refer also to abstract 17323.*

**16991** WADC-TR-57-266(Pt.1)

Wright Air Development Center. Materials Lab., Wright-Patterson AFB, Ohio and Wright Air Development Center. Power Plant Lab., Wright-Patterson AFB, Ohio.

EFFECTS OF NUCLEAR RADIATION ON ORGANIC FLUIDS. PART I. GAMMA RADIATION STABILITY OF CERTAIN MINERAL OILS AND DIESTER FLUIDS. Period Covered: January 1956 to March 1957. William L. R. Rice and James H. Way. May 1, 1957. 26p. Project title: RADIATION EFFECTS. Task title: RADIATION EFFECTS ON MATERIALS. (AD-130807).

A study was made of the stability to gamma radiation of certain refined petroleum oils and diester fluids. Testing of the irradiated fluids by means of lubricant evaluation procedures, such as viscosity, flash point, and oxidation-corrosion resistance, indicated that for the tests conducted, the mineral oils of the type studied should have general resistance to gamma radiation up to a dosage of about $1 \times 10^8$ roentgens. The diester fluid di-2-ethylhexyl sebacate (Plexol 201) had very poor stability to gamma radiation over the same range. Addition of 0.5% phenothiazine improved the radiation resistance of this base fluid, except for the loss of oxidative stability experienced at dosage levels of $1 \times 10^7$ roentgens and lower. Examination was made of the test data for the irradiated fluids to determine if any property changes followed the radiation exposure history. This was to discover if either the mineral oil or diester type fluids could be used as secondary reference standards for radiation calibration of non-uniform geometries exposed to nuclear radiation, such as bearing assemblies or circulating fluid loops. The changes offering the most promise were the increase in neutralization number of the diester fluid and the gas evolution of the mineral oils. (auth)

**16992**

DYNAMIC MECHANICAL BEHAVIOR OF IRRADIATED POLYETHYLENE. C. W. Deeley, J. A. Sauer, and A. E. Woodward (Pennsylvania State Univ., University Park). J. Appl. Phys. 29, 1415-21(1958) Oct.

Samples of a "high-density" polyethylene (p = 0.964 g/cc) irradiated in a nuclear reactor to thermal neutron doses as high as $2.9 \times 10^{18}$ nvt and of "low-density" polyethylene (p = 0.915 g/cc) subjected to gamma-ray bombardment from a $Co^{60}$ source up to a dosage of $1 \times 10^9$ rep have been investigated by dynamic mechanical methods from 80 to 450°K at audio-frequencies. Degrees of cross-linking were estimated from the observed changes in resonance frequency at temperatures where the specimens were "rubber-like." Densities and x-ray crystallinities at 25°C were also measured. For the pile-irradiated "high-density" polyethylene the $\gamma$ peak found around 165°K shows a marked increase in height and area at dosages above $10^{18}$ nvt. The $\alpha$ peak at about 390°K decreases markedly upon receiving a thermal neutron dose of $0.6 \times 10^{18}$ nvt. Further changes in this absorption with higher dosages are obscured by the appearance of a $\beta$ peak around 330°K which is almost absent in the unirradiated material; the appearance of the $\beta$ region is attributed to the creation of branch points and cross-link points in the essentially linear polymer by the irradiation. The irradiated "low-density" specimens exhibit three damping peaks. Over the dosage range studied the $\gamma$ peak (165°k) increases in height and area, the $\beta$ peak (270°K) shifts to higher temperatures, and the $\alpha$ peak (360°K) shifts to lower temperatures with increasing dose. The cross-linking degree is not proportional to dose and to the highest dosages studied, there is very little, if any, reduction in x-ray crystallinity. (auth)

## Rare Earths and Rare-earth Compounds

*Refer also to abstract 17159.*

**16993**

THE CONFIGURATION OF THE SOLVATE "ICEBERG" ABOUT $Eu^{+3}$ IN AQUEOUS AND ALCOHOLIC SOLUTIONS OF $EuCl_3$ . Donald G. Miller (Univ. of California, Livermore). J. Am. Chem. Soc. 80, 3576-9 (1958).

Models are proposed for the close-in structure of the solvate about the trivalent europium ion in aqueous and alcoholic solutions of $EuCl_3$. These models satisfy the spectroscopic conditions that the symmetries are $D_{2h}$ and $C_{2v}$, respectively, there is a single stable configuration about the ion in each case, and the close-in arrangements must be very similar. The models are the $Eu^{+3}$ ion in an interstitial position of the ice III lattice for aqueous solutions and in alcoholic solutions a pair of hydrogen bonded alcohol chains drawn in toward the $Eu^{+3}$ ion with possibly one or two nearby chloride ions. These models should be applicable to most of the other rare earths and smaller trivalent ions but probably not to lower valence types. (auth)

**16994**

THE CRYSTAL STRUCTURES OF SOME OF THE RARE EARTH CARBIDES. F. H. Spedding, K. Gschneider, Jr., and A. H. Daane (Iowa State Coll., Ames). J. Am. Chem. Soc. 80, 4499-4503(1958) Sept. 5.

A study of the rare earth-carbon systems was made. The existence of the reported $LaC_2$, $CeC_2$, $PrC_2$, $NdC_2$ and $SmC_2$, and the $Ce_2C_3$ was confirmed. The existence of the tetragonal $CaC_2$ type structure for the other rare earth dicarbides was shown. The lattice constants of these compounds decrease in a regular fashion, except for the $YbC_2$, whose lattice parameters lie between those of $HoC_2$ and $ErC_2$. The body-centered cubic $Pu_2C_3$ type structure exists in all of the rare earths from La to Ho. The lattice constants decrease in a normal manner, except for $Ce_2C_3$, whose lattice parameter is smaller than would be expected. A new rare earth carbide was found, $R_3C$, which is similar to the face-centered cubic NaCl type structure, except that it is deficient in carbon. This compound appears to exist over a range of composition, i.e., in the case of yttrium it was found to vary from $YC_{0.25}$ to $YC_{0.40}$. This compound exists in the rare earth-carbon systems of Sm to Lu, and the lattice parameters decrease in a regular manner. No x-ray evidence was found for the existence of this lower carbide in the La-, Ce-, Pr-, and Nd-C systems. (auth)

**16995**

THE THERMAL DECOMPOSITION OF YTTRIUM AND THE RARE EARTH METAL SULPHATE HYDRATES. Wesley W. Wendlandt (Texas Technological Coll., Lubbock). J. Inorg. & Nuclear Chem. 7, 51-4(1958) Aug.-Sept.

The thermal decompositin of lanthanum, cerium (III), praseodymium, neodymium, samarium, gadolinium, dysprosium, holmium, erbium, ytterbium, and yttrium sulfate hydrates was studied on the thermobalance. The formation of intermediate hydrates was more pronounced with the lighter rare earth elements than with the heavier ones. The first weight loss temperatures for the hydrated salts ranged from 40 to 110°C, while the minimum temperatures for the anhydrous metal sulfate levels ranged from 155 to 295°C. (auth)

**16996**

THE APPARENT MOLAR REFRACTION OF SOME AQUEOUS RARE EARTH NITRATES. Fredric D. Leipziger and John E. Roberts (Univ. of Massachusetts, Amherst). J. Phys. Chem. 62, 1014-16(1958) Aug.

The apparent Lorentz-Lorenz molar refraction and dispersion and the apparent molar volume of lanthanum, cerium, and neodymium nitrates have been determined at various concentrations. Values for the refractions of the aqueous ions have been calculated. The equation of Böttcher also has been applied to these measurements. (auth)

**16997**
PHYSICO-CHEMICAL PROPERTIES AND USES OF RARE-EARTH METALS. E. M. Savitskii (Inst. of Metallurgy, Academy of Sciences, USSR). Metalloved. i Obrabotka Metal. No. 8, 2-13(1958) Aug. (In Russian)

A review is presented on the properties, applications, and production of rare-earth metals. (R.V.J.)

## Separation Procedures

*Refer also to abstracts 17301, 17316, 17317, 17318, 17329, 17350, 17351, 17379, 17391, 17400, 17402, 17414, 17424, 17938, 17940, 17942, 17943, and 17944.*

**16998** AERE-C/R-1893
United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England.
CHEMICAL STUDIES RELATING TO THE RECOVERY OF NEPTUNIUM FROM THE WINDSCALE PLANT. E. Hesford and H. A. C. McKay. Feb. 1956. Decl. June 1958. 20p. $0.54(BIS).

The oxidation and reduction of neptunium were studied spectrophotometrically in solutions similar to those from which neptunium might be recovered at Windscale. It has been shown that the use of hydrazine as a reductant is complicated by the catalytic effect of iron on the destruction of the reagent. Attempts to recover $Np^{237}$ from Windscale highly active fission product effluent were partially successful. (auth)

**16999** BNL-511
Brookhaven National Lab., Upton, N. Y.
REPROCESSING OF POWER REACTOR FUELS. THE ENRICO FERMI FAST BREEDER REACTOR FUEL PROGRESS REPORT NO. 1. C. W. Pierce and B. Manowitz. June 1958. 9p. $0.50(OTS).

Studies on the recovery of U and Pu from the Enrico Fermi Fast Breeder Reactor fuel are presented. (W.L.H.)

**17000** JENER-57
Joint Establishment for Nuclear Energy Research, Kjeller, Norway.
SEPARATION OF U(VI), Pu(VI) AND Pu(IV) FROM Zr AND Nb ON A COLUMN OF SILICA GEL. D. Cvjetcanin. Aug. 25, 1958. 19p.

The chromatographic method for the separation of $U^{6+}$, $Pu^{6+}$, and $Pu^{4+}$ from $Zr^{95}$–$Nb^{95}$ on a silica gel column is described. It is possible to carry out the separation of these elements from aqueous, as well as from organic solutions. The method is based on the extraction of $U^{6+}$, $Pu^{6+}$, and $Pu^{4+}$ nitrates with methyl isobutyl ketone containing $HNO_3$ in the presence of silica gel. $Zr^{95}$–$Nb^{95}$ under the same conditions were retained by the silica gel. (auth)

**17001** NLCO-749
National Lead Co. of Ohio, Cincinnati.
THE TRIBUTYL PHOSPHATE–NITRIC ACID COMPLEX AND ITS ROLE IN URANIUM EXTRACTION. Thomas J. Collopy. Apr. 23, 1958. 15p. Contract AT(30-1)-1156. $0.75(OTS).

The distribution of nitric acid between tributyl phosphate and water at 25°C is shown for equilibrium aqueous nitric acid concentrations of 0 to 12 molar. Results are presented for uranium extraction from sulfate, chloride, fluoride, and phosphate systems with TBP and with TBP that contained an equimolar complex with nitric acid. (auth)

**17002** NRL-H-3385
Naval Research Lab., Washington, D. C.
THE SEPARATION OF HAFNIUM AND ZIRCONIUM BY LIQUID THERMAL DIFFUSION. John I. Hoover, Marvin Tetenbaum, and Howard S. Dryer. [1955?] 21p.

An attempt was made to separate hafnium and zirconium by liquid thermal diffusion utilizing liquid organic compounds of zirconium. Three compounds were investigated—zirconyl stearate, zirconium tetra isoamylate, and zirconium tetra 2-ethyl hexylate. In all cases the use of the salt was impractical due to undesirable physical properties. However, it is concluded that the method might be used successfully with a more ideal compound of zirconium. (auth)

**17003**
THE EXTRACTION OF PLUTONIUM FROM NEUTRON-IRRADIATED URANIUM BY URANIUM TRICHLORIDE AND BY MAGNESIUM CHLORIDE. D. E. McKenzie, W. L. Elsdon, and J. W. Fletcher (Atomic Energy of Canada Ltd., Chalk River, Ont., Can.). Can. J. Chem. 36, 1233-40(1958) Sept.

The extraction of plutonium from neutron-irradiated uranium by uranium trichloride and by magnesium chloride was examined in the temperature range 1150 to 1250°C. The results of the uranium trichloride experiments were used to evaluate the standard free-energy change of the equilibrium reaction $UCl_3 + Pu \rightleftharpoons PuCl_3 + U$. These free-energy values were used to predict the plutonium extraction in the magnesium chloride experiments on the assumption that the uranium trichloride, continuously formed from the non-equilibrium reaction $\frac{3}{2} MgCl_2 + U \rightarrow UCl_3 + \frac{3}{2} Mg$, rapidly established the above equilibrium with the plutonium in the uranium. Agreement between predicted and experimental results supports this assumption. A preliminary study of the kinetics of the $MgCl_2$–U reaction showed that the initial rate of reaction is controlled by the distillation of magnesium metal from the reaction zone. (auth)

**17004**
MASS TRANSFER BEHAVIOR IN FIXED BEDS. James O. Osburn (State Univ. of Iowa, Iowa City). Chem. Eng. 67, No. 18, 143-5(1958) Sept. 8.

Design methods for fixed-bed operations such as gas chromatography, ion exchange, and absorption are presented. The length of the packed bed and its effect on the outlet concentration are of primary interest. Simple adsorption is used to remove a substance from a fluid stream, while elution or chromatographic separations are used for substances adsorbed on a bed of adsorbent. These principles are considered along with application of theoretical plate methods to fixed-bed operations. (J.R.D.)

**17005**
SOLVENT EXTRACTION STUDIES. PART II. THE SYSTEM NITRIC ACID–WATER–Tri-n-BUTYL PHOSPHATE. D. G. Tuck (Univ. of Manchester, Eng.). J. Chem. Soc., 2783-9(1958) Aug.

The extraction of nitric acid from aqueous solution by tri-n-butyl phosphate has been investigated. From the volume changes it has been shown that up to ~3.6 M-acid in the organic phase the extraction is due to the formation of $Bu_3PO_4,HNO_3$ by addition at the strongly polar P → O group. When this donor oxygen is saturated, further addition takes place at the less basic oxygen atom of a P–O–C bond; in this case, the acid is shown to be extracted as $H_2O,HNO_3$. The experimental results are discussed in relation to mass-action equations derived for these two types of equilibrium. (auth)

**17006**

PROTACTINIUM. III. SOLVENT EXTRACTION FROM HALIDE SOLUTIONS. A. G. Goble and A. G. Maddock (University Chemical Lab., Cambridge, Eng.). J. Inorg. & Nuclear Chem. 7, 94-112(1958) Aug.-Sept.

The extraction of protactinium from chloride solutions by a number of organic solvents has been investigated and the effects of the acidity and chloride concentrations in the aqueous phase measured. It is shown that these and other results can be explained in terms of the distribution between the two phases of an ion-pair complex formed by a chloro-anion containing the metal and an onium cation containing water and solvent molecules. The extracting power of the solvent therefore depends on its base strength, or ability to form the cationic complex, as well as its dielectric constant. Dissociation or association of the ion-pairs may become important in the organic phase, so that departures from a simple distribution law may be found at some concentrations of the extracting metal. These departures can be correlated with the dielectric constant of the solvent. The effect on the extraction of strong acids, such as perchloric acid, and the use of solutions of the higher amines in benzene and benzonitrile are explained in terms of this model. Extraction from sulfate and thiocyanate solutions has also been investigated. (auth)

**17007**

THE BACK-EXTRACTION OF URANYL NITRATE FROM TRIBUTYL PHOSPHATE SOLUTION. Taichi Sato (Government Chemical Industrial Research Inst., Tokyo). J. Inorg. & Nuclear Chem. 7, 147-9(1958) Aug.-Sept.

Sulfuric, hydrochloric, acetic, and oxalic acids, their ammonium and sodium salts, and ammonium and sodium carbonate were used as back-extraction agents for uranyl nitrate from TBP solution, and the results are tabulated and an evaluation made. (J.R.D.)

**17008**

PROPERTIES OF A NEW STRONG BASE ANION EXCHANGER CONTAINING STRUCTURALLY-BOUND TERTIARY SULFONIUM CATIONS. S. Lindenbaum, G. E. Boyd, and G. E. Myers (Oak Ridge National Lab., Tenn.). J. Phys. Chem. 62, 995-9(1958) Aug.

Selectivity coefficients, rates of anion exchange, water absorption isotherms, and the absorptions of Zn(II) and Fe(III) from concentrated electrolyte solutions were measured using a new, methylene cross-linked, strong-base anion exchanger containing structurally-bound tertiary sulfonium cations. The selectivity coefficient scale, determined using thirteen anion salt forms, was nearly identical with that for quaternary ammonium type anion exchangers. The greater the water uptake at saturation vapor pressure by a given salt form the greater the bromide ion affinity. The tertiary sulfonium anion exchanger was appreciably more hydrated at low water vapor activities than the quaternary ammonium type, whereas the converse held for high water activities. The self-exchange of bromide ion in the sulfonium exchanger at 25° occurred with a self-diffusion coefficient of $1.18 \times 10^{-7}$ $sec^{-1}$, which value is notably smaller than the coefficient observed with a comparable quaternary ammonium type exchanger at the same temperature. Micro-quantities of Zn(II) and Fe(III) were strongly absorbed from hydrochloric acid and lithium chloride solutions, and this absorption increased with electrolyte concentration in a manner similar to that found with quaternary ammonium type anion exchangers. (auth)

**17009**

THE REPROCESSING OF REACTOR FUEL ELEMENTS L. Klichler and W. Schüller (Farbwerke Hoechst AG., Frankfurt/Main-Hoechst). Nukleonik 1, 112-24(1958) Aug. (In German)

A review is given of the processing of reactor fuel elements. One section is devoted to the Purex Process. 74 references. (J.S.R.)

**17010**

COMPLEX COMPOUNDS OF THORIUM OXALATE WITH AMMONIUM OXALATE. K. N. N. Kurup, K. V. Nair, and S. S. Moosath (Univ. of Kerala, Trivandrum, India). Proc. Indian Acad. Sci. A47, 373-8(1958) June.

The system thorium oxalate-ammonium oxalate-water was investigated by physico-chemical methods. A new procedure is adopted in preparing the solution for these studies by the mono-variation method. Data are presented to prove the existence of two complexes in solution from measurements of electrical resistance, pH, and relative viscosity. (auth)

**17011**

PRODUCTION OF CARRIER-FREE $Re^{183}$ BY A METHOD BASED ON BREAKAGE OF CHEMICAL BONDS AT $\beta$ DISSOCIATION. V. D. Nefedov and M. A. Toropova. Zhur. Neorg. Khim. 2, No. 7, 1667-71(1957). (Translated from Referat. Zhur. Khim., No. 2, 1958, Abstract No. 3735)

A rapid method of separating carrier-free $Re^{183}$ using $W(CO)_6$ (I) was developed. $Re^{183}$ generates at the $\beta$ dissociation of $W^{183}$ formed by the successive capture of two neutrons by a $W^{182}$ nucleus. $WCl_6$ was obtained from $WO_3$ (irradiated with slow neutrons), after which I was obtained and purified of inorganic Re forms by distillation with steam and sublimation in vacuo. 500 mg of (I) was dissolved in 10 ml of chloroform and the solution was aged in order to accumulate $Re^{183}$. It was extracted with 10 ml of distilled water, the aqueous layer was washed twice with ether. The extracted $Re^{183}$ is quantitatively and radiochemically pure. No formation of $Re^{183m}$ was revealed during the dissociation of $W^{183}$. When the $Re^{183}$ accumulation was carried out in crystalline I, about 60% of $Re^{183}$ was found to be in inextractable form. Synthesis of $Re(CO)_5$ takes place under these conditions.

## Sorption Phenomena

**17012** NP-tr-147

THEORY OF ION EXCHANGE DYNAMICS. IV. EQUATION OF MOTION OF A STEADY FRONT. V. V. Rachinskii. Translated by M. C. Wheeler (U.K.A.E.A. Atomic Energy Research Establishment) from Zhur. Fiz. Khim. 31, 444-51(1957). 14p.

The theory of the dynamics and kinetics of ion exchange with a regime of parallel transfer of a sorption wave front is considered. The steady front motion equation was tested by the use of a radiochromatographic method and found to be in agreement with the experimental results. (J.R.D.)

**17013**

ADSORPTION AND DIFFUSION OF INERT GASES ON TUNGSTEN. Robert Gomer (Univ. of Chicago). J. Chem. Phys. 29, 441-2(1958) Aug.

The adsorption and diffusion of Ar, Ne, and Xe on tungsten field emitters were studied by an extension of techniques used for chemisorbates, employing a universal gas source. The work presents the first visual proof of multilayer adsorption and shows that physisorption of clean metals results in energies not different from other substrates. (auth)

**17014**
ADSORPTION OF PLUTONIUM BY SOIL. D. W. Rhodes (General Electric Co., Richland, Wash.). Soil Sci. 84, 465-71(1957) Dec.

Information concerning the reactions of plutonium with soil as a result of waste disposal methods at Hanford is presented. (J.E.D.)

## Spectroscopy

**17015** ORNL-2569
Oak Ridge National Lab., Tenn.
A STUDY OF PRE-ACCELERATION IN BETA-RAY SPECTROSCOPY. W. O. Olson, H. H. Hubbell, Jr., and R. D. Birkhoff. Oct. 2, 1958. 78p. Contract W-7405-eng-26. $12.30(ph OTS); $4.50(mf OTS).

Experimental and theoretical studies show that acceleration of beta rays between the source and a beta spectrometer can increase the count rate by increasing the momentum increment transmitted by the spectrometer and can reduce considerably the absorption in the detector window. A double hemispherical accelerator was constructed with annular slots to permit electrons to escape into the acceptance angle of a spectrometer of the solenoidal homogeneous magnetic field type. An unsupported cylindrical window Geiger counter of 0.5 mg/cm$^2$ formvar was constructed and used in the spectrometer. The transmission of the counter was evaluated by noting the departure from linearity of the Fermi plot of a thin source of $Pm^{147}$. The transmission of the counter window was 100% down to about 80 kev, fell to 90% about 45 kev, then dropped steeply to a cutoff at 15 kev. Theoretical studies indicate that the true momentum distribution $N_1(p)$ is related to the observed counts per minute (c/m) by $N_1(p) = c/m/(I_{p'})^2\, I_p\, [1 + \Delta E/T + m_0c^2]$ where $I_p$ is the current for which the spectrometer transmits beta rays of initial energy T. The larger current $I_{p'}$ is the current at which the c/m are observed for beta rays of initial energy T which acquire an additional energy $\Delta E$ in the accelerator. After the effects of counter window absorption and the artificial widening of the momentum window had been removed from the spectra, the following effect of the accelerating field could be observed. More focusing was found for small disk sources than for larger ones. Ring sources emitting through small axial apertures behaved similarly, with smaller apertures giving greater focusing. For example, the ratio between the corrected momentum spectrum with acceleration to that without acceleration varied from 1 for $\Delta E/T = 0.1$ to 1.8 for $\Delta E/T = 1$ for a particular ring source. Calculations of the effects of the accelerating field on the electron trajectories indicate that no distortion should be expected for the first case, but that considerable rotation of trajectories about the axis of the spectrometer would be expected in the latter case. Theoretically such rotations may be avoided for quite large (~10) values of $\Delta E/T$ provided the ratio of radii of the inner and outer spheres is kept below 0.1, but no experimental verification was possible here. An $\alpha$-ray source was used to monitor counter efficiency. This source could be uncovered by remote control either manually or as a part of the automatic spectrometer scanning cycle. (auth)

**17016**
SYMPOSIUM ON SPECTROCHEMICAL ANALYSIS FOR TRACE ELEMENTS. ASTM Special Technical Publication No. 221. Presented at the Sixtieth Annual Meeting American Society for Testing Materials, Atlantic City, N. J., June 18, 1957. Philadelphia, American Society for Testing Materials, 1958. 82p. $2.75.

Topics discussed include the following: emission spectrometric determination of oxygen in metals; spectrographic determination of trace elements in metals; trace analysis by means of the graphite spark; principles of quantitative biological emission spectrography; applications of emission spectroscopy to trace element analysis in plant and soil samples; and spectrochemical analysis for trace elements in geological materials. (C.H.)

## Syntheses

**17017** RMD-222-Q1
Thiokol Chemical Corp. Reaction Motors Div., Denville, N. J.
RESEARCH ON SYNTHESIS OF HIGH TEMPERATURE STABLE ORGANO PHOSPHOROUS DERIVATIVES. First Quarterly Report for April 15, 1958 to July 15, 1958. D. D. Perry and S. Mutnick. 25p. RMD Project No. 222. Contract AF33(616)-5653.

A literature survey of methods applicable to synthesis of organophosphorus compounds and of pertinent physical properties of these materials was conducted, with emphasis on methods which are capable of giving high yields. In addition, the synthesis of aryl dialkyl phosphine oxides was investigated by conversion of phosphorus trichloride to phosphine oxide via the tertiary phosphine and an oxidation step, and by introducing desired alkyl groups to an aryl phosphorus oxydichloride by reaction with an organometallic reagent. (J.R.D.)

**17018**
AN APPARATUS FOR THE PRODUCTION OF LABELLED SULPHURIC ACID FROM SULPHUR TRIOXIDE AND DEUTERIUM OR TRITIUM LABELLED WATER.
P. Avinur (Weizmann Inst. of Science, Rehovot, Israel). Bull. Research Council Israel Sect. A, 7A, 129-34(1958) June.

An apparatus for the production of labelled sulfuric acid from deuterium or tritium labelled water and distilled sulfur trioxide is described. With this apparatus it is possible to produce various amounts of labelled acid up to about 200 g of acid per hour. The possibility of producing pure oleum is discussed. (auth.)

**17019**
PREPARATION OF $C^{14}$-FORMATE BY A BIOSYNTHETIC METHOD. P. K. Bhattacharyya and B. D. Kulkarni (National Chemical Lab., Poona). J. Sci. Ind. Research (India) 17C, 95-100(1958) June.

$C^{14}$ formate was prepared in good yields from $C^{14}$ carbonate by a biosynthetic procedure using E. Coli cells. The apparatus, method, and materials used are described. (J.R.D.)

## Tracer Applications

**17020**
FRACTIONATION OF SULFUR ISOTOPES DURING OXIDATION. Iwaji Iwasaki, Hiroshi Fukutomi, and Hikaru Shimojima (Tokyo Inst. of Tech.). Bull. Chem. Soc. Japan 31, 495-6(1958) May.

The fractionation process of sulfur isotopes during oxidation and the distribution of sulfur isotopes in nature using sulfur-35 as a tracer were examined. Zinc sulfide labeled with $S^{35}$ was prepared from hydrogen sulfide and zinc acetate, and about $1/10$ of the total was

oxidized to the sulfate. The sulfide was filtered off and the sulfate precipitated with barium sulfate. The process was repeated until all the sulfide was consumed, producing about 10 samples of barium sulfate, the radioactivities of which were measured by the infinite thickness method. (J.R.D.)

**17021**
FRACTIONATION OF SULFUR ISOTOPES DURING REDUCTION. Iwaji Iwasaki, Hikaru Shimojima, and Hiroshi Fukutomi (Tokyo Inst. of Tech.). Bull. Chem. Soc. Japan 31, 496(1958) May.

Barium sulfate labelled with sulfur-35 was reduced, and hydrogen sulfide evolved from the reactions was entrained with carbon dioxide. The gas was led into two absorbing cells in series, the first of which contained a known amount of aqueous zinc acetate, for radioactivity measurement, and the second contained cadmium carbonate for sulfide detection. When sufficient zinc sulfide was obtained in each absorbing cell, the flow was diverted to a new cell series so that many small equal fractions were obtained. The counting rate of each sample was measured by the infinite thickness method. (J.R.D.)

**17022**
KINETICS OF THE ISOTOPIC EXCHANGE IN THE SYSTEM $CO_2$ - $O_2$ WITH $^{18}O$ AS A TRACER IN A TRANSPARENT QUARTZ VESSEL. C. A. Bank (Laboratorium voor Massaspectrografie, Amsterdam). J. Inorg. & Nuclear Chem. 7, 145-6(1958) Aug.-Sept.

The kinetics of the isotopic exchange between $CO_2$ and $O_2$ was measured at 820, 850, and 900°C. The exchange reaction was performed in a 30-mm diam. cylindrical quartz vessel with a volume of 92 ml using oxygen containing 0.79% $O^{18}$. The rate of isotopic equilibration is calculated, and the results are presented in tables and charts. (J.R.D.)

**17023**
USE OF RADIOACTIVE ISOTOPES IN THE PROCESSING OF PETROLEUM. T. Filotti. Petrol. si gaze 8, No. 4, 198-204(1957). (Translated from Referat. Zhur. Khim. No. 1, 1958, Abstract No. 2515)

A survey is presented of the possibilities of utilizing radioactive isotopes in studying the flow of liquids at petroleum processing plants, measuring the volume of liquids in containers, and in treatment process control.

**17024**
PRESENT STATE AND PROSPECTS OF THE UTILIZATION OF RADIOACTIVE ISOTOPES IN PROCESSING, TRANSPORTATION, STORAGE AND USE OF PETROLEUM AND PETROLEUM PRODUCTS. Yu. S. Zaslavskiy. Sbornik Primenen. radioakt. izot. i izluchen. v. neft. prom. Moscow. Gostoptekhizdat. 84-99(1957). (Translated from Referat. Zhur. Khim. No. 1, 1958, Abstract No. 2514)

A review is presented on tracer techniques used in the petroleum industry. 13 references. (J.S.R.)

## Transuranic Elements and Compounds

**17025** AEC-tr-3309
A STUDY OF COMPLEX OXALATES OF PLUTONIUM BY USING THE POLAROGRAPHIC METHOD. V. V. Fromin, S. P. Vorob'ev, and M. A. Andreev. Translated by the Oak Ridge National Lab. Library Staff from Atomnaya Energ. 4, 57-62(1958). 14p.

The composition and stability of complex ions of tri- and tetravalent plutonium in oxalate solutions were investigated. The oxalate ion concentration range was $10^{-13}$ to 1.2M, and a polarograph with an automatic recorder was used to produce the current-force-voltage curves. The experimental procedure is described, and results are tabulated. (J.R.D.)

**17026** AEC-tr-3380
ON THE PROBLEM OF PRODUCTION OF TRIVALENT NEPTUNIUM. A. D. Gelman and M. P. Mefodieva. Translated by Lydia Venters (Argonne National Lab.) from Doklady Akad. Nauk S.S.S.R. 117, 225-6(1957). 5p.

The preparation of Np(III) by the action of sodium sulfoxylate formaldehyde on acid solutions of Np(IV) was investigated. Almost complete reduction to Np(III) takes place in hydrochloric acid solution and to a lesser degree in nitric acid solution. (J.R.D.)

**17027**
TETRAVALENT AMERICIUM AND CURIUM; THE ABSORPTION SPECTRA OF THE TRI- AND TETRAFLUORIDES OF THESE ELEMENTS. L. B. Asprey and T. K. Keenan (Los Alamos Scientific Lab., N. Mex.). J. Inorg. & Nuclear Chem. 7, 27-31(1958) Aug.-Sept.

A technique has been developed for spectral examination of sub-milligram amounts of solid compounds. The absorption spectra of curium(IV) fluoride and americium(IV) fluoride have been measured. A Cary Model 14M Recording Spectrophotometer was used to record the spectra over the region 3500 to 20,000 A. (auth)

## Uranium and Uranium Compounds

*Refer also to abstracts 17289 and 17360.*

**17028** GAT-250
Goodyear Atomic Corp., Portsmouth, Ohio.
CONSTANT TEMPERATURE BLENDER FOR SYNTHETIC URANIUM ISOTOPIC STANDARDS. W. S. Stringham. Sept. 10, 1958. 7p. Contract AT(33-2)-1. $0.50(OTS).

A constant temperature blender has been developed which makes possible almost 100 percent certainty in the homogenization of different isotopic uranium standards for use in mass spectrometer analyses. (auth)

**17029** KAPL-1873
Knolls Atomic Power Lab., Schenectady, N. Y.
THE BEHAVIOR OF $UO_2$ BODIES SUBJECTED TO TEMPERATURE TRANSIENTS. W. C. Cohen and D. F. Molino. July 1, 1957. 31p. Contract W-31-109-Eng-52. $1.00(OTS).

The results of an experimental investigation of the expansion behavior of $UO_2$ bodies subjected to temperature transients similar to those experienced during reactor power excursions are reported. These results indicate that for the conditions studied, solid cylindrical $UO_2$ pieces of ~70% of theoretical density exhibited a positive linear coefficient of expansion (2 to $8 \times 10^{-6}$/°C) of approximately the same magnitude as that reported in the literature for $UO_2$ bodies measured under equilibrium conditions. (auth)

**17030** TEM-942
Geological Survey, Washington, D. C.
PRELIMINARY EXPERIMENTS ON THE REDUCTION OF THE URANYL ION TO URANINITE BY CARBONACEOUS SUBSTANCES. Irving A. Breger and Richard T. Moore. Aug. 1955. 12p. $3.30(ph OTS); $2.40(mf OTS).

An aqueous solution of uranyl sulfate containing a suspension of subbituminous coal has been heated at

210°C for three days. Examination of the coal at the end of the experiment showed it to contain 31.8 percent uranium recognizable as uraninite by a sharp, strong x-ray diffraction pattern. A similar experiment with degraded spruce wood also led to the formation of uraninite but in lesser quantity and with broader lines in the x-ray diffraction pattern. The ability of coal or wood to reduce the uranyl ion is a critical factor in the correlation of studies of uraniferous coals containing the uranyl ion with studies of uraninite-bearing coalified wood from the Colorado Plateau. Although these results are based on preliminary experiments, they are extremely important geochemically and warrant the development of the series of controlled studies that are proposed. (auth)

**17031**

COMPLEX FORMATION BETWEEN $U^{IV}$ AND DI-(2 BUTYLOCTYL) + PYROPHOSPHATE. M. Zangen (Atomic Energy Commission, Israel). Bull. Research Council Israel Sect. A, 7A, 153-64(1958) June.

The extraction of uranium(IV) from phosphoric acid by di-(2-butyloctyl)-pyrophosphate (BOPPA), diluted with organic solvents, has been investigated under various conditions in order to establish the parameters of the process. BOPPA in kerosene (SBP 60-90°C) at concentrations ranging from 2.5 to 640 millimoles/l was employed as solvent. The aqueous phase consisted of $U^{IV}$ (0.03-8 millimoles/l) in phosphoric acid. Various volume ratios (2.5-40) of the aqueous and the organic phase were tested in a batch extraction process. It was found that no single simple equilibrium equation governing the extraction process could be set up: the simultaneous formation of at least three complexes—$U(BOPP)_2$ $U(BOPP)(H_2PO_4)_2$ and $U_2(BOPP)(H_2PO_4)_6$—has to be postulated in order to explain the experimental data satisfactorily. Approximate values have been determined for the equilibrium constants governing formation and extraction of the above complexes. (auth)

**17032**

EXTRACTION OF URANYL SULFATE WITH AMINES. Ch. Boirie (Commissariat a l'Energie Atomique, Gif-sur-Yvette, Saclay, France). Bull. soc. chim. France No. 8-9, 1088-93(1958) Aug.-Sept. (In French)

The extraction of uranyl sulfate with long-chain amines was studied. The formulas of the compounds formed with different amines in solutions of carbon tetrachloride were established. The effect of several factors were controlled. Di-n-decylamine was chosen to study the amine sulfate/uranyl sulfate equilibrium and to determine its dissociation constant. (tr-auth)

**17033**

THE DIPHENATES OF THORIUM, CERIUM, ZIRCONIUM, AND URANIUM. COMPOSITION, STRUCTURE, AND PROPERTIES. HETEROMETRIC STUDY. M. Bobtelsky and A. H. I. Ben-Bassat (Univ. Hebraique, Jerusalem). Bull. soc. chim. France No. 8-9, 1138-44(1958) Aug.-Sept. (In French)

Thorium nitrate forms with diphenic acid (D) at pH ~ 4 the soluble complex $(Th_2D)^6$ which is quantitatively changed into insoluble ThD. Cerium(III) nitrate forms, in a solution containing 50% ethyl alcohol at a pH 4 to 5, the final insoluble compound $Ce(III)D_3$ and the intermediate compounds Ce(III)D and $Ce(III)D_2$. Zirconium nitrate forms the final insoluble compound ZrD (ZrOD). The intermediate compounds have the composition $Zr_4D$ (soluble), $Zr_3D$, and $Zr_2D$. Uranium nitrate forms with diphenic acid only solutions. In the presence of thorium nitrate it forms quantitatively an insoluble compound (or a co-precipitate) having the composition $ThUD_4$. Solutions of thorium and cerium nitrate with a concentration of approximately 0.002M can be determined in solution by the heterometric method. Uranium can be determined in solutions containing thorium by the same method if the molecular concentration of uranium is less that 1(U):1(Th). (tr-auth)

**17034**

THE DOUBLE FLUORIDES OF TETRAVALENT URANIUM IN THE METALLURGY OF URANIUM. G. Imarisio and R. Sesini (CISE, Milan). Energia nucleare (Milan) 5, 522-6(1958) Aug. (In Italian)

A review is made of the several methods involved in the production of uranium fluorides which are suitable for reduction to uranium metal. The fluoride reduction appears to be a convenient way for obtaining uranium metal. Uranium tetrafluorides and uranium-alkaline metals or alkaline earth metal fluorides were found to be the most suitable compounds to be employed for this purpose. (tr-auth)

**17035**

A SHORT PROCEDURE FOR ELECTRODEPOSITING FISSIONABLE ELEMENTS. A. Brodsky, L. W. Fagg, and T. D. Hanscome (Naval Research Lab., Washington). Health Phys. 1, 189-91(1958) Sept.

Electrodeposition seems to be the best method for producing thin, hard, adherent, and uniform deposits of fissionable elements. Several procedures are available in the literature. Some of these procedures were used by the authors in attempts to produce thin films of 100 to 400 $\mu g\ U/cm^2$ of platinum, but the yields obtained with these quantities were variable, and deposits were often flaky and uneven. Other procedures were too elaborate for the purpose at hand. The procedure given in this article was developed to afford an easy and reliable method of obtaining deposits of fissionable elements for use as neutron detectors. It has been used to obtain thin, uniform deposits of uranium, thorium, and neptunium. All deposits were found to be hard and adherent enough to resist mild rubbing with forceps. For the sixteen uranium deposits prepared by this method, the yields were measured radiometrically. The uranium deposited on the first disc with a yield of 74%, and after a slight increase in the cell current, yields of from 87 to 100% were obtained for the remaining fifteen deposits. Thus, modifications of this method may be useful for urinalysis of uranium. After first coating an aluminum foil of about 5 in. × 5 in. with zincate solution the procedure described was also used to cover the foil with a uniform layer of natural uranium having an $\alpha$-count at 50% geometry of 200 counts/min per $cm^2$. The deposit came down in high yield and was similar in appearance and quality to the uranium deposits on the platinum discs. This foil was made for use as an $\alpha$-calibration source for measuring foils exposed in an electrostatic precipitator. The details of the electrodeposition procedure and apparatus are described. (auth)

**17036**

REACTION OF HYDROGEN WITH URANIUM. W. M. Albrecht and M. W. Mallett (Battelle Memorial Inst., Columbus, Ohio). J. Electrochem. Soc. 105, 610-11 (1958) Oct.

An addendum is presented to report BMI-982, in which the kinetics of the reaction to produce constant compositions of $UH_x$ is discussed. (J.E.D.)

**17037**

THE INTERACTION OF URANIUM TETRACHLORIDE WITH HYDRAZINE, AMMONIA AND AMINES. Ilmars Kalnins and George Gibson (Illinois Inst. of Tech.,

Chicago). J. Inorg. & Nuclear Chem. 7, 55–65(1958) Aug.–Sept.

Equilibrium vapor-pressure studies at 35 to 55°C of the systems $UCl_4$ – m $RNH_2$ (R = H, $CH_3$, $C_2H_5$, n–$C_3H_7$) in the range of m = 2 to 5 revealed a univariant behavior indicating a solid solution of $UCl_4$ in the corresponding ligand. At m = 4 the ligand pressure increases very rapidly with further increase in the ligand composition indicating the approach of a saturation limit. Evidence obtained from x-ray and thermal desorption studies indicates the existence of addition compounds of the stoicheiometry: $UCl_4 \cdot 2NH_3$, $UCl_4 \cdot 2CH_3NH_2$, $UCl_4 \cdot C_2H_5NH_2$, $UCl_2 \cdot 2C_2H_5NH_2$, and $UCl_4 \cdot$ n–$C_3H_7NH_2$. The addition compounds $UCl_4 \cdot 6N_2H_4$ and $UO_2 \cdot N_2H_4$ also seem to exist although the latter was not isolated. All of the above-mentioned systems appear to be stable indefinitely when stored in sealed ampules. They react, however, with water vapor and oxygen to give either $UO_2$ or $UO_2Cl_2$ and ligand hydrochloride as the solid products. The enthalpy, free energy and enthropy of formation in $UCl_4$–amine systems were found to increase with increasing alkyl chain length. The values of these thermodynamic quantities at a given composition, however, depend on the history of preparation of the initial solid phase. A considerable improvement of the $UCl_4$ x-ray powder diagram was observed after some gaseous amine was added to the solid $UCl_4$ at room temperature to form a second, solid $UCl_4$–$RNH_2$ phase. The infra-red spectrum of $UCl_4 \cdot 4$n–$C_3H_7NH_2$ differs from the spectra of its components by having some additional absorption peaks. Since not enough is known at present concerning characteristic U–N absorption frequencies no specific assignment of peaks was made. (auth)

**17038**

A CONTRIBUTION TO SODIUM POLYURANATE CHEMISTRY. Jaromír Malý and Václav Veselý (Inst. of Nuclear Physics, Praha, Czechoslovakia). J. Inorg. & Nuclear Chem. 7, 119–28(1958) Aug.–Sept.

The preparation of sodium polyuranates by mixing sodium hydroxide solutions with uranyl nitrate and vice versa was studied by potentiometric titration. Points of inflection indicated the presence of polyuranates with different Na : U ratios and of a polyuranate with the empirical formula $(UO_3H_2O)_5N_2O_5$. Polymerization and hydrolysis of uranyl ions in the solution during titration were indicated by changes in the absorption spectra and in pH. Solid polyuranates with empirical formual $(UO_3H_2O)_5N_2O_5$ and $(UO_3H_2O)_n Na_2O$ were obtained, n having values from 16 to 3. The dependence of the polyuranate composition on the pH of the titration solutions was investigated. Polyuranates of formula $(UO_3H_2O)_5N_2O_5$ and $(UO_3H_2O)_n Na_2O$ (n = 16 and 5) have similar orthorhombic structures. The unit cell has dimensions a = 7.09 ± 0.02 A, b = 9.55 ± 0.02 A, c = 5.11 ± 0.06 A. The structure of polyuranates with n < 5 is different. (auth)

**17039**

EXTRACTION, PROPERTY, AND USES OF URANIUM. Marian Chrzanowski. Przeglad. Tech. No. 12, 500–2(1956). (Translated from Referat. Zhur. Fiz. No. 5, 1957, Abstract No. 11328.)

**17040**

TO THE QUESTION OF $UI_4 \rightleftharpoons UI_3 + I$ EQUILIBRIUM. M. M. Popov and M. D. Senin. Zhur. Neorg. Khim. 2, No. 7, 1479–81(1957). (Translated from Referat. Zhur. Khim. No. 2, 1958, Abstract No. 3759)

The reaction $UI_4 \rightleftharpoons UI_3 + I$ was investigated at 1097 to 1176°K by freezing the equilibrium state and analizing dissociation products. The equilibrium constant $K_p = P_I / P_{UI_4} = 4.57 \times 10^{-2}$ at 1097°K and $5.37 \times 10^{-2}$ at 1176°K. The reaction heat of $UI_3$ (liquid) + I (gas) = $UI_4$ (gas) at 1136°K was computed to be 5.2 ± 0.7 kcal per mole, the maximum work at 1097°K is A = 6.73 ± 0.05 and at 1176°K is A = 6.83 ± 0.01 kcal per mole. The density of $UI_3$ was found to be $d_4^{25} = 6.38$ per $cm^3$. The melting point is 766.5 ± 1°C.

**17041**

THE EXTRACTION OF URANIUM AS ANILIN-URANYL-TRIACETATE. V. M. Vdovenko and L. N. Lazarev. Zhur. Neorg. Khim. 3, 155–9(1958). (In Russian)

The possibility of extracting uranyl acetate with aniline was demonstrated. It was shown that aniline uranyl acetate was formed in the organic phase. This compound was separated and its chemical properties were determined. (J.S.R.)

## Waste Disposal

**17042**

SOIL DISPOSAL OF RADIOACTIVE WASTES AT ORNL: CRITERIA AND TECHNIQUES OF SITE SELECTION AND MONITORING. K. E. Cowser and F. L. Parker (Oak Ridge National Lab., Tenn.). Health Phys. 1, 152–63 (1958) Sept.

The ability of soil to remove and retain the bulk of the fission product cations from aqueous solution is used as the basis for disposal of large volumes of intermediate level wastes. An experimental system consisting of three 1 million gal disposal pits has been developed at ORNL and through December 1956, received a total of 5.6 million gal of waste containing 58,000 c of $Cs^{137}$, 15,000 c of $Ru^{106}$ and lesser amount of $Sr^{89}$, $Sr^{90}$, $Co^{60}$, $Sb^{125}$ and the rare earths. Sodium ion and nitrate ion account for the largest part of the chemical constituents. The geologic and hydrologic characteristics of the reservation served as a guide in the selection of small areas for detailed study. The information obtained from field studies of a specific area and laboratory investigations of the interaction of waste and typical soil were used to estimate the operating characteristics of a disposal pit. After the pit was in operation, the underground movement of the chemical constituents and radionuclides in the waste was followed by sampling and radiologging observation wells and sampling at stream gauging points in the pit area. These results have confirmed the preoperating estimate of the direction and path of waste movement and the seepage of anion materials such as $Ru^{106}$ and $NO_3^-$ through the soil. (auth)

**17043**

DESERT BASINS AND WASTE DISPOSAL. Wallace de Laguna (Oak Ridge National Lab., Tenn.). Health Phys. 1, 195–200(1958) Sept.

Problems to be considered in the disposal of radioactive liquid wastes by ground disposal in desert basins are reviewed. (C.H.)

## ENGINEERING

**17044** CF-58-6-52

Oak Ridge National Lab., Tenn.

STRESS ANALYSIS OF CONICAL SHELLS. F. J. Stanek. Aug. 28, 1958. 142p. Contract W-7405-eng-26. $21.30(ph OTS); $6.90(mf OTS).

The fundamentals for the stress analysis of conical shells by use of the classical small-deflection theory

have been presented in various texts, but before the development of the high-speed computing machines it was not feasible to present the analysis in a convenient and usable form. With the aid of these high-speed machines, all necessary functions can be evaluated by the fundamental analyst and tabulated in a convenient form for use by the design engineer. It is the intent of this report to bridge the gap between theory and design. Parts I and II are sufficient for the analysis of a specific conical shell. Part III consists of several illustrative examples and the necessary additional equations for "connecting" a cylinder or a flat circular plate to either end of a cone. These equations pertain to the "funnel" and the "flower pot" problems, respectively. Part IV gives the derivation of the conical-shell formulas, and part V consists of tables of values of the Schleicher functions and their first derivatives, which form the core for the values of almost all the other required functions but do not apply directly in the stress analysis of conical shells. (auth)

**17045** NACA-RM-E57K12
Lewis Flight Propulsion Lab., Cleveland.
PRELIMINARY STUDIES OF ROLLING-CONTACT FATIGUE LIFE OF HIGH-TEMPERATURE BEARING MATERIALS. Thomas L. Carter. Apr. 1, 1958. 28p.

Preliminary studies of rolling-contact fatigue life of both races and balls of some promising high-temperature bearing materials were made at room temperature in the rolling-contact fatigue spin rig. The results may be of assistance in judging the relative potential of bearing steels for use at high temperatures. The following materials were investigated: SAE 52100, MHT, TMT, MV-1, Halmo vacuum-melt, and AISI T-1, M-10, M-1, and M-50. (auth)

**17046** SCTM-106-58(16)
Sandia Corp., Albuquerque, N. Mex.
EVALUATION OF DIVISION 1611, 10-POUND DROP TABLE. R. O. Brooks. June 11, 1958. 35p. Contract AT(29-1)-789. $6.30(ph OTS); $3.00(mf OTS).

A 10-pound drop table is evaluated. The discussion includes theory of shock; instrumentation utilizing Statham and Endevco accelerometers; the effects of different test loads, springs, spring lengths, and drop heights upon shock values; resonant frequencies; shock repeatability; calibration reliability; material fatigue; design changes (existing and proposed); interesting conditions noted; typical calibration curves; and an operating procedure for the table. (auth)

**17047** WASH-170(Del.)
Division of Engineering, AEC.
THIRD ATOMIC ENERGY COMMISSION AIR CLEANING CONFERENCE HELD AT LOS ALAMOS SCIENTIFIC LABORATORY, SEPTEMBER 21, 22, AND 23, 1953. Nov. 1954. Decl. with deletions Mar. 13, 1957. 372p., 1 illus. $59.40(ph OTS); $11.10(mf OTS).

The operating performance of air-cleaning facilities at AEC installations is reviewed, and fundamental information obtained from basic studies of aerosol behavior is presented. Separate abstracts have been prepared for each paper. (W.L.H.)

**17048** WASH-170(Del.)(p.7-10)
Los Alamos Scientific Lab., N. Mex.
LOS ALAMOS AIR CLEANING ACTIVITIES. J. B. Graham. p.7-10 [of] THIRD ATOMIC ENERGY COMMISSION AIR CLEANING CONFERENCE HELD AT LOS ALAMOS SCIENTIFIC LABORATORY, SEPTEMBER 21, 22, AND 23, 1953 (deleted). 4p.

A brief explanation of the organization and the type of work being done by the various parts of the organization at the Los Alamos Scientific Laboratory is presented. (W.L.H.)

**17049** WASH-170(Del.)(p.11-12)
Los Alamos Scientific Lab., N. Mex.
THE LOS ALAMOS INCINERATOR. H. F. Schulte. p.11-12 of THIRD ATOMIC ENERGY COMMISSION AIR CLEANING CONFERENCE HELD AT LOS ALAMOS SCIENTIFIC LABORATORY, SEPTEMBER 21, 22, AND 23, 1953 (deleted). 2p.

Results of a series of test runs and modifications to the incinerator are presented. (W.L.H.)

**17050** WASH-170(Del.)(p.13-20)
Carbide and Carbon Chemicals Co. Y-12 Plant, Oak Ridge, Tenn.
VENTILATION AND AIR CLEANING FACILITIES FOR NORMAL URANIUM FABRICATION. W. H. Baumann. p.13-20 [of] THIRD ATOMIC ENERGY COMMISSION AIR CLEANING CONFERENCE HELD AT LOS ALAMOS SCIENTIFIC LABORATORY, SEPTEMBER 21, 22, AND 23, 1953 (deleted). 8p.

The level of air contamination reached high proportions in the normal U processing areas which include the foundry and machining operations. After a study of machining operations it was decided that the polishing operation was most dusty. Two hoods were installed, and a substantial reduction in air contamination was noted. In the design of the facilities, the contractor provided exhaust outlets, piping, and exhausters. Fibrous filters were incorporated in the hoods in an effort to capture the dust as close to the source as possible. The factors responsible for the reduction in air-borne uranium are presented. (W.L.H.)

**17051** WASH-170(Del.)(p.21-35)
Oak Ridge National Lab., Tenn.
THE HANDLING OF RADIOACTIVE-CONTAMINATED AIR AT OAK RIDGE NATIONAL LABORATORY. W. G. Stockdale. p.21-35 [of] THIRD ATOMIC ENERGY COMMISSION AIR CLEANING CONFERENCE HELD AT LOS ALAMOS SCIENTIFIC LABORATORY, SEPTEMBER 21, 22, AND 23, 1953 (deleted). 15p.

The systems in use at Oak Ridge National Laboratory for decontamination of radioactive-contaminated air and its final disposal are described. The air-cleaning facilities for the ORNL Graphite Reactor, laboratories and chemical plants, radiochemical process vessel off-gas, and Homogeneous Reactor Experiment are described. (W.L.H.)

**17052** WASH-170(Del.)(p.40-7)
General Electric Co. [Hanford Atomic Products Operation], Richland, Wash.
HANFORD AIR CLEANING OPERATIONS. A. G. Blasewitz. p.40-7 [of] THIRD ATOMIC ENERGY COMMISSION AIR CLEANING CONFERENCE HELD AT LOS ALAMOS SCIENTIFIC LABORATORY, SEPTEMBER 21, 22, AND 23, 1953 (deleted). 8p.

A brief summary is presented of the operating experience which has been obtained at Hanford with the deep bed fibrous glass filters and silver reactors for the filtration of air from the separations plants. Alternative filter equipment which is under consideration for the filtration of the ventilation air for separation plants is described. (W.L.H.)

**17053** WASH-170(Del.)(p.48-54)
Argonne National Lab., Lemont, Ill.
AIR CLEANING ACTIVITIES AT ARGONNE NATIONAL LABORATORY. D. P. O'Neil. p.48-54 [of] THIRD ATOMIC ENERGY COMMISSION AIR CLEANING CON-

FERENCE HELD AT LOS ALAMOS SCIENTIFIC LABORATORY, SEPTEMBER 21, 22, AND 23, 1953 (deleted). 7p.

An investigation of the absorption of some halogen gases from an air stream by various methods is presented. An economic study on the use of prefilters in laboratory hoods is included. (W.L.H.)

**17054** WASH-170(Del.)(p.55-7)
Argonne National Lab., Lemont, Ill.
VENTILATION ACTIVITIES AND PROGRAMS AT ARGONNE NATIONAL LABORATORY. R. W. Van Valzah. p.55-7 of THIRD ATOMIC ENERGY COMMISSION AIR CLEANING CONFERENCE HELD AT LOS ALAMOS SCIENTIFIC LABORATORY, SEPTEMBER 21, 22, AND 23, 1953 (deleted). 3p.

A brief description is presented of the ventilation system at the Argonne National Laboratory. (W.L.H.)

**17055** WASH-170(Del.)(p.58-62)
Argonne National Lab., Lemont, Ill.
THE ARGONNE INCINERATOR PROGRAM. W. A. Rodger and D. C. Hampson. p.58-62 [of] THIRD ATOMIC ENERGY COMMISSION AIR CLEANING CONFERENCE HELD AT LOS ALAMOS SCIENTIFIC LABORATORY, SEPTEMBER 21, 22, AND 23, 1953. (deleted). 5p.

A description is presented of the Argonne active waste incinerator. (W.L.H.)

**17056** WASH-170(Del.)(p.63-7)
Idaho Operations Office, AEC.
AIR CLEANING PROBLEMS AT NRTS. A. L. Biladeau. p.63-7 [of] THIRD ATOMIC ENERGY COMMISSION AIR CLEANING CONFERENCE HELD AT LOS ALAMOS SCIENTIFIC LABORATORY, SEPTEMBER 21, 22, AND 23, 1953 (deleted). 4p.

Prefiltering of all air for the plants is required because of dust. The air cleaning facilities for the Chemical Processing Plant are described. The air cleaning facilities for the Materials Testing Reactor and Experimental Breeder Reactor are briefly discussed. (W.L.H.)

**17057** WASH-170(Del.)(p.68-78)
New York Operations Office. Health and Safety Lab., AEC and Mallinckrodt Chemical Works, St. Louis.
OPERATING ECONOMICS OF AIR CLEANING EQUIPMENT UTILIZING THE REVERSE JET PRINCIPLE. William B. Harris and Mont G. Mason. p.68-78 [of] THIRD ATOMIC ENERGY COMMISSION AIR CLEANING CONFERENCE HELD AT LOS ALAMOS SCIENTIFIC LABORATORY, SEPTEMBER 21, 22, AND 23, 1953 (deleted). 11p.

Plant experiences with the operation of 18 dust collectors is described. This equipment, supplied by two different manufacturers, is in continuous operation in one plant. The units are operated at housing pressures from 2" of water to 10" of mercury with capacities from 700 cubic feet per minute on pneumatic conveying to 12,000 cfm on dust control. The total designed capacity is 110,000 cfm. Dust loading varies from 0.002 grains per cubic foot to 32 grains per cubic foot, with an average of 5 grains per cubic foot. Discharge air measures 0.0001 grains per thousand to 0.41 grains per thousand with an average of 0.16. Average cleaning efficiencies range from 99.946 to 99.9996 with an average under all conditions of 99.986. Over-all annual cost, including five-year amortization, is 0.32 dollars per year per cfm for all equipment and 0.23 dollars per year per cfm for suitably designed equipment. This compares with three large wet collectors which have been described. They operate at 93.5% collection with an annual cost of 0.197 dollars per cfm. Maintenance costs of the wool felt collectors alone amount to 0.12 dollars per year per cfm for all units and 0.042 dollars per year per cfm for 14 adequately designed collectors. (auth)

**17058** WASH-170(Del.)(p.79-86)
Catalytic Construction Co., Philadelphia.
VENTILATION AND DUST CONTROL IN REFINING URANIUM ORES AND CONCENTRATES. H. I. Miller, Jr. p.79-86 of THIRD ATOMIC ENERGY COMMISSION AIR CLEANING CONFERENCE HELD AT LOS ALAMOS SCIENTIFIC LABORATORY, SEPTEMBER 21, 22, AND 23, 1953 (deleted). 8p.

Some of the problems and their solutions in the design of control facilities for health protection in a large uranium producing plant are discussed. (W.L.H.)

**17059** WASH-170(Del.)(p.87-97)
General Electric Co. Aircraft Nuclear Propulsion [Dept., Cincinnati].
TESTS OF THE AERODYNE DUST COLLECTOR. Warren H. Smith. p.87-97 [of] THIRD ATOMIC ENERGY COMMISSION AIR CLEANING CONFERENCE HELD AT LOS ALAMOS SCIENTIFIC LABORATORY, SEPTEMBER 21, 22, AND 23, 1953 (deleted). 12p.

The efficiency of an Aerodyne Dust Collector was determined as a function of dust concentration for values below 1 grain/cubic foot. Copper oxide powder was the test dust, with an experimentally determined mass median of 4.3 $\mu$ and with no particles observed above 9 $\mu$. (W.L.H.)

**17060** WASH-170(Del.)(p.99-101)
[Westinghouse Electric Corp. Atomic Power Div., Pittsburgh.]
BRIEF SUMMARY OF AIR CLEANING PROGRAM AT WESTINGHOUSE ATOMIC POWER DIVISION, PITTSBURGH, PA. E. C. Barnes. p.99-101 [of] THIRD ATOMIC ENERGY COMMISSION AIR CLEANING CONFERENCE HELD AT LOS ALAMOS SCIENTIFIC LABORATORY, SEPTEMBER 21, 22, AND 23, 1953 (deleted). 3p.

A brief description is given of the dust collecting equipment which is being used to take care of a wide variety of dusts, fumes, and vapors. (W.L.H.)

**17061** WASH-170(Del.)(p.102-17)
Weather Bureau, Idaho Falls, Idaho.
TOWER OBSERVATIONS OF ATMOSPHERIC DUST AT THE NATIONAL REACTOR TESTING STATION. P. A. Humphrey, E. M. Wilkins, and D. M. Morgan. p.102-17 [of] THIRD ATOMIC ENERGY COMMISSION AIR CLEANING CONFERENCE HELD AT LOS ALAMOS SCIENTIFIC LABORATORY, SEPTEMBER 21, 22, AND 23, 1953 (deleted). 16p.

The 250-foot radio tower in the central facilities area was used to elevate high-volume air samplers to various heights above the ground. Concentrations of dust near the ground are much higher during periods of strong winds, but at 250 feet they are no higher than during periods of light or moderate winds. There is little practical difference between concentrations during lapse conditions and inversion conditions as long as wind speeds are about the same. The decrease of dustiness with height shows a distinct advantage in having air intakes located at the highest feasible elevations. (W.L.H.)

**17062** WASH-170(Del.)(p.118-41)
Knolls Atomic Power Lab., Schenectady, N. Y.
KAPL AIR CLEANING PROGRAM. L. J. Cherubin and J. J. Fitzgerald. p.118-41 [of] THIRD ATOMIC ENERGY COMMISSION AIR CLEANING CONFERENCE HELD AT LOS ALAMOS SCIENTIFIC LABORATORY, SEPTEMBER 21, 22, AND 23, 1953 (deleted). 22p.

A brief description of the air cleaning requirements at the Knolls Atomic Power Laboratory is given. A total of 407,600 cfm of air is cleaned in which the CWS-6 filter units are used to clean approximately 80 per cent of the air at the Laboratory. Caustic scrubbers and an electrostatic precipitator are utilized in specific air cleaning operations. The efficiency of the air cleaning units is indicated by the low concentrations of radioactive and toxic materials in the environs which are tabulated. The collection efficiencies of six filter media used for air cleaning and air sampling are tabulated as a function of face velocity and particle size. (auth)

**17063** WASH-170(Del.)(p.142-5)
Brookhaven National Lab., Upton, N. Y.
BROOKHAVEN AIR CLEANING OPERATIONS. Lee Gemmell. p.142-5 [of] THIRD ATOMIC ENERGY COMMISSION AIR CLEANING CONFERENCE HELD AT LOS ALAMOS SCIENTIFIC LABORATORY, SEPTEMBER 21, 22, AND 23, 1953 (deleted). 4p.

The operation and performance of filters used in prefiltering air for the pile and filtering discharged gases before stack disposal are presented. (W.L.H.)

**17064** WASH-170(Del.)(p.155-60)
Du Pont de Nemours (E. I.) & Co. [Savannah River Lab., Augusta, Ga.].
AIR CLEANING PROBLEMS AT THE SAVANNAH RIVER PLANT. J. R. Clark. p.155-60 [of] THIRD ATOMIC ENERGY COMMISSION AIR CLEANING CONFERENCE HELD AT LOS ALAMOS SCIENTIFIC LABORATORY, SEPTEMBER 21, 22, AND 23, 1953 (deleted). 7p.

The design of air-cleaning facilities in the process areas is described. (W.L.H.)

**17065** WASH-170(Del.)(p.165-9)
Ames Lab., Ames, Iowa.
AIR HANDLING FACILITIES AT THE AMES LABORATORY. R. W. Fisher. p.165-9 [of] THIRD ATOMIC ENERGY COMMISSION AIR CLEANING CONFERENCE HELD AT LOS ALAMOS SCIENTIFIC LABORATORY, SEPTEMBER 21, 22, AND 23, 1953 (deleted). 5p.

The Ames Laboratory installation is primarily concerned with two types of air handling: a general type for supplying fresh air to the buildings proper and special filtering centers for handling contaminated air from various process areas. (auth)

**17066** WASH-170(Del.)(p.170-84)
California. Univ., Berkeley. Radiation Lab.
SITE AND CONTRACTOR ACTIVITIES AND PROGRAMS, U. C. RADIATION LABORATORY. M. D. Thaxter. p.170-84 [of] THIRD ATOMIC ENERGY COMMISSION AIR CLEANING CONFERENCE HELD AT LOS ALAMOS SCIENTIFIC LABORATORY, SEPTEMBER 21, 22, AND 23, 1953 (deleted). 15p.

The Radiation Laboratory handles over 99% of its isotope curies in Berkeley boxes. The air cleaning problems are intimately connected with the use of these boxes. A description is presented of the boxes and the air-cleaning system. (W.L.H.)

**17067** WASH-170(Del.)(p.185-90)
California Research and Development Co. [Livermore Research Lab.], Livermore, Calif.
AIR CLEANING PROGRAM AT THE LIVERMORE RESEARCH LABORATORY. G. T. Saunders. p.185-90 [of] THIRD ATOMIC ENERGY COMMISSION AIR CLEANING CONFERENCE HELD AT LOS ALAMOS SCIENTIFIC LABORATORY, SEPTEMBER 21, 22, AND 23, 1953 (deleted). 6p.

A brief summary of the air-cleaning program is presented. (W.L.H.)

**17068** WASH-170(Del.)(p.191-204)
Weather Bureau, Idaho Falls, Idaho.
METEOROLOGICAL ASPECTS OF AIR CLEANING. P. A. Humphrey and E. M. Wilkins. p.191-204 of THIRD ATOMIC ENERGY COMMISSION AIR CLEANING CONFERENCE HELD AT LOS ALAMOS SCIENTIFIC LABORATORY, SEPTEMBER 21, 22, AND 23, 1953. (deleted). 14p.

A review of the effects of vertical temperature gradient on stack gas behavior is presented. The appearance of stack effluent is regulated largely by the configuration of the vertical gradient of air density or temperature. With respect to a high stack on nearly level terrain there are five different configurations of the vertical temperature gradient that occur, and these usually have a diurnal cycle. The five different configurations are described. (W.L.H.)

**17069** WASH-170(Del.)(p.205-17)
Ohio State Univ., Columbus.
FIBROUS AEROSOL FILTERS. C. E. Lapple. p.205-17 [of] THIRD ATOMIC ENERGY COMMISSION AIR CLEANING CONFERENCE HELD AT LOS ALAMOS SCIENTIFIC LABORATORY, SEPTEMBER 21, 22, AND 23, 1953 (deleted). 11p.

The fundamental performance characteristics of fibrous filters are discussed. A method has been presented for generalizing the principles governing deposition of aerosol particles in fibrous packing by the mechanisms of flow-line interception, inertial interception, and diffusional deposition. Experimental data were obtained which express these principles quantitatively for an interaction number of 2140. In the absence of more extensive data over a range of interaction numbers, a method is suggested for utilizing the present data for general design or performance estimates. (W.L.H.)

**17070** WASH-170(Del.)(p.218-21)
California. Univ., Berkeley. Radiation Lab.
AIR CLEANING—NEW DEVELOPMENTS AT U. S. RADIATION LABORATORY. M. D. Thaxter. p.218-21 [of] THIRD ATOMIC ENERGY COMMISSION AIR CLEANING CONFERENCE HELD AT LOS ALAMOS SCIENTIFIC LABORATORY, SEPTEMBER 21, 22, AND 23, 1953 (deleted). 4p.

A small vertical gas scrubber is described for the entire or partial removal of corrosive vapors. A completely closed ventilation system glove box is described for high specific activity material. (W.L.H.)

**17071** WASH-170(Del.)(p.222-6)
California. Univ., Berkeley. Radiation Lab.
A CONSTANT VOLUME RADIOCHEMICAL HOOD. G. T. Saunders. p.222-6 [of] THIRD ATOMIC ENERGY COMMISSION AIR CLEANING CONFERENCE HELD AT LOS ALAMOS SCIENTIFIC LABORATORY, SEPTEMBER 21, 22, AND 23, 1953 (deleted). 5p.

Design, operation, and cost of a constant volume radiochemical hood are presented. (W.L.H.)

**17072** WASH-170(Del.)(p.227-34)
Chemical Corps, Washington, D. C. and Air Force, [Washington, D. C.].
FILTRATION OF MICROORGANISMS FROM AIR BY GLASS FIBER PAPER FILTERS. Herbert M. Decker, J. Bruce Harstad, Frank J. Piper, and Myrl E. Wilson. p.227-34 [of] THIRD ATOMIC ENERGY COMMISSION AIR CLEANING CONFERENCE HELD AT LOS ALAMOS SCIENTIFIC LABORATORY, SEPTEMBER 21, 22, AND 23, 1953 (deleted). 8p.

The development of ultra microfine glass fiber paper filters for removal of biological and radiological contamination from air supply systems is presented. (W.L.H.)

**17073** WASH-170(Del.)(p.235-50)
Harvard Univ., Boston. School of Public Health.
FURTHER STUDIES ON ELECTROSTATIC SEPARATION. A. T. Rossano, Jr. p.235-50 [of] THIRD ATOMIC ENERGY COMMISSION AIR CLEANING CONFERENCE HELD AT LOS ALAMOS SCIENTIFIC LABORATORY, SEPTEMBER 21, 22, AND 23, 1953 (deleted). 16p.

Results of continuing research on the electrostatic effects in fiber filters are presented. Experimental studies on the effects of aerosol charge on filter efficiency are presented. (W.L.H.)

**17074** WASH-170(Del.)(p.251-61)
Harvard Univ., Boston. School of Public Health.
FURTHER STUDIES OF FABRIC DUST COLLECTORS. Charles E. Billings, Richard Dennis, and Leslie Silverman. p.251-61 [of] THIRD ATOMIC ENERGY COMMISSION AIR CLEANING CONFERENCE HELD AT LOS ALAMOS SCIENTIFIC LABORATORY, SEPTEMBER 21, 22, AND 23, 1953 (deleted). 11p.

In conjunction with studies on commercial dust collectors, the laboratory has conducted performance tests on a Simon Suction Filter. Performance tests were also made on a reverse-jet filter. A comparison of the Simon Suction Filter with the reverse-jet filters at equal filtration velocities, dust loadings, and with maximum cleaning capacity shows that the Simon Suction Filter penetration and resistance are on the average of 7.1 and 2.3 times higher, respectively. (W.L.H.)

**17075** WASH-170(Del.)(p.262-71)
Harvard Univ., Boston. [School of Public Health].
PERFORMANCE CHARACTERISTICS OF THE MODEL K ELECTRO-POLAR FILTER. Preliminary Report. Richard Dennis, Charles E. Billings, and Leslie Silverman. p.262-71 [of] THIRD ATOMIC ENERGY COMMISSION AIR CLEANING CONFERENCE HELD AT LOS ALAMOS SCIENTIFIC LABORATORY, SEPTEMBER 21, 22, AND 23, 1953 (deleted). 10p.

Results of preliminary performance tests are presented for the "Electro-polar Filter," an experimental dust collector. The Electro-polar Filter consists essentially of a dielectric filter medium of fine glass fibers placed in an electric field. (W.L.H.)

**17076** WASH-170(Del.)(p.272-80)
Harvard Univ., Boston. Air Cleaning Lab.
COTTON AEROSOL FILTER STUDIES. Preliminary Report. Richard D. Coleman. p.272-80 [of] THIRD ATOMIC ENERGY COMMISSION AIR CLEANING CONFERENCE HELD AT LOS ALAMOS SCIENTIFIC LABORATORY, SEPTEMBER 21, 22, AND 23, 1953 (deleted). 9p.

Studies have been conducted on the filtration characteristics of various cotton fibers for atmospheric dusts. Four natural fibers and two ion exchange coatings were investigated. The use of cotton fibers as filter media has prospects for economy because cotton has relatively low initial cost, has low ash for economical disposal, and is readily available. (W.L.H.)

**17077** WASH-170(Del.)(p.281-304)
Bureau of Mines, Pittsburgh.
INCINERATION OF COMBUSTIBLE WASTES USING TANGENTIAL OVERFIRE AIR. L. A. Spano and R. C. Corey. p.281-304 [of] THIRD ATOMIC ENERGY COMMISSION AIR CLEANING CONFERENCE HELD AT LOS ALAMOS SCIENTIFIC LABORATORY, SEPTEMBER 21, 22, AND 23, 1953 (deleted). 24p.

The operation and performance of a prototype incinerator are discussed. The model incinerator consisted of a 55-gallon steel drum with a small axial stack at the top of the drum and four pairs of tangential parts, 180 degrees apart, located at different levels of the drum. Results of tests on the incinerator are presented. (W.L.H.)

**17078** WASH-170(Del.)(p.305-29)
Little (Arthur D.) Inc., Cambridge, Mass.
PROPERTIES OF VARIOUS FILTERING MEDIA FOR ATMOSPHERIC DUST SAMPLING. W. J. Smith and N. F. Surprenant. p.305-29 [of] THIRD ATOMIC ENERGY COMMISSION AIR CLEANING CONFERENCE HELD AT LOS ALAMOS SCIENTIFIC LABORATORY, SEPTEMBER 21, 22, AND 23, 1953 (deleted). 25p.

A group of atmospheric dust sample media was studied for performance characteristics. The media were selected to represent those in use in a number of laboratories. Test methods used were dioctyl phthalate smoke penetration, atmospheric dust penetration, efficiency by particle size, and plugging rate on atmospheric dust. A wide range of properties was shown. (W.L.H.)

**17079** WASH-170(Del.)(p.330-3)
Little (Arthur D.) Inc., Cambridge, Mass.
SURVEY OF AIR SAMPLING MEDIA AND SAMPLING METHODS USED AT A.E.C. AREAS AND BY OTHERS. W. J. Smith. p.330-3 [of] THIRD ATOMIC ENERGY COMMISSION AIR CLEANING CONFERENCE HELD AT LOS ALAMOS SCIENTIFIC LABORATORY, SEPTEMBER 21, 22, AND 23, 1953 (deleted). 4p.

The survey was conducted by questionnaire. (W.L.H.)

**17080** WASH-170(Del.)(p.334-48)
Knolls Atomic Power Lab., Schenectady, N. Y.
EVALUATION OF THE KAPL SEPARATIONS PROCESS STACK EFFLUENT. J. J. Fitzgerald. p.334-48 [of] THIRD ATOMIC ENERGY COMMISSION AIR CLEANING CONFERENCE HELD AT LOS ALAMOS SCIENTIFIC LABORATORY, SEPTEMBER 21, 22, AND 23, 1953 (deleted). 15p.

The KAPL Separations Process stack effluent is evaluated. The adequacy and the efficiency of all the sampling instruments are determined. The size of the particles entrained in the stack are studied under both the light and the electron microscope. The mean particle size is less than 0.05 microns. Autoradiographs of the particulate material indicate that the majority of the activity is deposited on these sub-micron particles. Chemical separations of the material deposited on the Hollingsworth and Vose, H-70 filter papers and the caustic scrubber are made. The rare earths comprise the largest portion of the particulate activity while Ru-106 is given off in relatively large quantities during the Head End Operation. The relative percentages of the activities given off during the most important phase of the Separations Process are tabulated. The KAPL stack effluent is then evaluated on the basis of the MPC recommended in the Bureau of Standards Handbook 52. (auth)

**17081** WASH-170(Del.)(p.351-5)
[Illinois. Univ., Urbana. Engineering Experiment Station].
TURBULENT DEPOSITION AND THE BEHAVIOR OF DEPOSITS OF SOLID PARTICLES. S. K. Friedlander. p.351-5 [of] THIRD ATOMIC ENERGY COMMISSION AIR CLEANING CONFERENCE HELD AT LOS ALAMOS SCIENTIFIC LABORATORY, SEPTEMBER 21, 22, AND 23, 1953 (deleted). 5p.

Equations are derived to predict the turbulent deposition and the behavior of deposits of solid particles. (W.L.H.)

**17082** WASH-170(Del.)(p.356-65)
[Illinois. Univ., Urbana. Engineering Experiment Station.]
COLLECTION OF AEROSOLS BY FIBER MATS. James B. Wong. p.356-65 [of] THIRD ATOMIC ENERGY COMMISSION AIR CLEANING CONFERENCE HELD AT LOS ALAMOS SCIENTIFIC LABORATORY, SEPTEMBER 21, 22, AND 23, 1953 (deleted). 10p.

A major class of aerosol filters consists of beds of individual fibers. The efficiency of collection and the pressure drop are the important practical considerations in the design of these fibrous filters. In this work, emphasis is placed on the mechanism of inertial impaction. This mechanism takes place when a particle approaching a fiber crosses the streamlines because of its inertia and strikes the surface of the fiber. The work is divided into two parts. Part one investigates the impaction of aerosol particles on single cylinders (metallic wires) with axes perpendicular to the direction of the aerosol flow. Part two deals with the collection efficiency and the pressure drop of fiber mats. (W.L.H.)

**17083** WASH-170(Del.)(p.366-73)
[Illinois. Univ., Urbana. Engineering Experiment Station].
FILTRATION OF SUBMICRON SIZE AEROSOLS BY FIBROUS MEDIA. C. Y. Chen. p.366-73 [of] THIRD ATOMIC ENERGY COMMISSION AIR CLEANING CONFERENCE HELD AT LOS ALAMOS SCIENTIFIC LABORATORY, SEPTEMBER 21, 22, AND 23, 1953. (deleted). 8p.

A study of the filtration of aerosol particles through a fiber mat both theoretically and experimentally is presented. (W.L.H.)

**17084** WASH-170(Del.) (p.374-83)
[Illinois. Univ., Urbana. Engineering Experiment Station].
INFLUENCES OF ELECTROSTATIC FORCES ON THE DEPOSITION OF AEROSOLS. H. F. Kraemer. p.374-83 [of] THIRD ATOMIC ENERGY COMMISSION AIR CLEANING CONFERENCE HELD AT LOS ALAMOS SCIENTIFIC LABORATORY, SEPTEMBER 21, 22, AND 23, 1953 (deleted). 10p.

The purpose of the current research is to investigate the mechanisms of aerosol deposition under the influence of electrostatic forces and to indicate the conditions and types of equipment wherein electrical charging may be beneficial. (W.L.H.)

**17085** AEC-tr-3299
REGULATION OF A 300 t/hr BENSON BOILER (Regelung cines 300t/h-Benson-Kessels). J. Frensch. Translated for Oak Ridge National Lab. from Mitt. Ver. Grosskesselbesitzer No. 43, 253-8(1956). 17p.

Experiments are described which led to an optimum control system for a Benson boiler. (T.R.H.)

**17086** AEC-tr-3300
REGULATION OF A SULZER SINGLE-TUBE STEAM GENERATOR (Regelung des Sulzer-Einrohr-Dampferzeugers). P. Profes. Translated for Oak Ridge National Lab. from Mitt. Ver. Grosskesselbesitzer No. 43, 258(1956). 36p.

The operating principle and control of the Sulzer single-tube steam generator are described and depicted. (T.R.H.)

**17087**
CURRENT COSTS OF VESSELS AND MOTOR REDUCERS. Harold Gushin (General Aniline & Film Corp., Linden, N. J.). Chem. Eng. 67, No. 18, 141-2(1958) Sept. 8.

The installed costs versus volume of various vessels including accessories are presented in graphical form. The data are for steel storage tanks with volumes of 500 to 50,000 gallons, and jacketed kettles with volumes of 500 to 4,000 gallons. Also included is a chart representing the cost versus horsepower of motor reducer-starter combinations for agitators. (J.R.D.)

**17088**
HIGH TEMPERATURE ENVIRONMENTS ASSOCIATED WITH JET PROPULSION. F. L. Bagby, A. E. Weller, and B. Steginsky (Battelle Memorial Inst., Columbus, Ohio). Chem. Eng. Progr. 54, No. 9, 58-62(1958) Sept.

The broad scope of high-temperature environmental conditions that designers of airframes and propulsion systems must contend with in achieving supersonic and hypersonic flight speeds is developed and presented. The basic environmental variables considered are temperature, duration, heat flux, chemistry, and force. It is pointed out that none of these variables are new or unique in themselves but unusual combinations of these variables are, particularly the role of chemistry in combination with temperature and high rates of heat transfer. (J.R.D.)

**17089**
PRESSURE VESSELS. LET THE TUBES SUPPORT THE TUBE SHEET. G. D. Galletly and C. R. Garbett (Shell Development Co., Emeryville, Calif.). Ind. Eng. Chem. 50, 1227-30(1958) Sept.

Substantial monetary and material economics in tube sheet thickness may be effected by taking advantage of the support offered by the tube bundle. In exploration of this design method, values for the ligament and deflection efficiencies must be determined. In addition the effects of tube bowing, in-place forces, and transient thermal effects must be investigated. (J.R.D.)

**17090**
AN APPARATUS FOR HEATING SMALL SAMPLES TO ELEVATED TEMPERATURES AT HIGH PRESSURES. J. Fennell, N. H. Hancock, and R. S. Barnes (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Metal Treatment and Drop Forging 25, 332-4(1958) Aug.

An apparatus incorporating a pressure-vessel capable of withstanding an internal gas pressure of 6,000 lb/sq in. at a temperature of 950°C is described. Gas from cylinders is compressed by a pump to the pressure required, and the high temperature is obtained by lowering a furnace over the end of the pressure vessel which contains the sample. (auth)

**17091**
SYNTHETIC LUBRICANTS. Arkadily Il'ich Dintses and Aleksandra Vasil'yevna Druzhinina. Moscow, Gostoptekhizdat, 1958. 350p.

In this book intended for the specialist in the field of selecting, synthesizing, and using lubricants, synthetic lubricants for equipment and machines which operate under high and low temperatures and heavy loads where a high coefficient of friction is present are discussed. The synthetic hydrocarbon oils, polysiloxane liquids (silicones), esters prepared from carboxylic acids, polyalkylene glycols, fluorine, and carbon chlorofluorides are examined. The additives used in preparing lube oils are also discussed. (J.S.R.)

## Heat Transfer and Fluid Flow

*Refer also to abstracts 17306, 17805, and 17951.*

**17092** AERE-CE/R-2496
United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England.
A REVIEW OF TWO-PHASE HEAT TRANSFER (1935-

1957). J. G. Collier. May 1958. 122p. $3.75(BIS).

A review is presented of the published literature dealing with heat transfer to two-phase gas-liquid mixtures flowing in vertical and horizontal tubes under natural or forced circulation. Both single component and two component two-phase heat transfer is dealt with. From this analysis of the literature a general appraisal of the mechanisms of heat transfer is made. Special sections include those on the effects of agitation and surface on nucleate boiling. Recommendations for further work on the subject are put forward. (auth)

**17093** WAPD-TH-412

Westinghouse Electric Corp. Bettis Plant, Pittsburgh. 1.3:1 "HOT PATCH" BURNOUT TESTS AT 800, 1200, AND 2000 PSIA IN A 0.093 IN. × 1 IN. × 27 IN. LONG RECTANGULAR CHANNEL. A. Weiss. [Aug. 1958.] 18p. $3.30(ph OTS); $2.40(mf OTS).

Tests were performed to investigate the effect of a flux peak ("hot patch") on the burnout heat flux in a 0.093 in. × 1 in. × 27 in. long rectangular channel with vertical upflow of water. The test specimens were machined to have a flux peak ($\phi_{peak}/\phi_{ave}$ and $L_{peak}/D_e$) the same as the HOTCHA I and II subassemblies. They had a 1.3 to 1 flux peak ($\phi_{peak}/\phi_{ave}$) for a length of 1.5 in. at a distance of 0.375 in. from the channel exit (channel $L/D_e$ = 153, "hot patch" $L/D_e$ = 8.5). The range of variables investigated included inlet temperatures of 100 to 440°F, mass velocities of $0.5 \times 10^6$ to $3.5 \times 10^6$ lb/hr-ft$^2$ and pressures of 800, 1200, and 2000 psia. The results of these tests indicate that a 1.3:1 flux peak of this type has no apparent effect on the burnout flux (a zero peak effectiveness exists) for the fluid conditions and pressures investigated. (auth)

**17094** AEC-tr-3311

REGULATION OF THE BENSON BOILER. (Die Regelbarkeit des Benson-Kessels). G. Schroeder. Translated for Oak Ridge National Lab. from Mitt. Ver. Grosskesselbesitzer 43, 235-40(1956). 20p.

Regulation of the Benson boiler is reviewed. Problems associated with boiler behavior during load fluctuations are discussed, and conclusions drawn from the role of the storage capacity and firing delay for the Benson boiler are examined in detail. It is pointed out that firing must be accurate and adjustable, and in the selection of firing the control—technological points of view should be closely followed. (J.R.D.)

**17095** AEC-tr-3379

HEAT TRANSFER COEFFICIENTS FOR EVAPORATING REFRIGERANTS. E. Hofmann. Translated by Lydia Venters (Argonne National Lab.) from Kältetechnik 9, No. 1, 7-12(1957). 21p.

Several recently published papers dealing with experiments to determine the heat transfer to evaporating liquid refrigerants at different heating surfaces are reviewed. The results are studied and correlated from a uniform point of view. Diagrams are presented ready for use. (auth)

**17096** AERE-Lib/Trans-796

HEAT CONDUCTION IN FLUIDS. L. Graetz. Translated by W. G. Olscher (U.K.A.E.A. Atomic Energy Research Establishment) from Ann. Physik. U. Chem. (Wied.) (3), 25, 337-57(1885). 19p.

In the first article under this title (Graetz, Wied. Ann. 18, 79(1883)) a new method of examining the conduction of heat in fluids was described and its application to certain observations given. The use of the method was subject to several difficulties, since the mathematical theory could not be extended sufficiently far to enable the constants which appeared to be determined. In the present paper the theory is fully developed. (J.E.D.)

**17097**

IMPROVEMENT OF THE HEAT TRANSFER IN WATER BY ARTIFICIAL ROUGHENING OF THE SURFACES IN REACTORS OR HEAT EXCHANGERS. Günther Grass. Atomkern-Energie 3, 328-31(1958) Aug.-Sept. (In German)

Heat transfer and pressure drop in tubes were tested at different surface roughnesses. Influence of surface roughness was found to be essential for both heat transfer and pressure drop in the same degree. It is possible to get heat exchangers with 2 to 3 times greater heat input by artificial surface roughness. (auth)

**17098**

SPEED HEAT EXCHANGER COMPUTATIONS. Ning Hsing Chen (M. W. Kellogg, Jersey City, N. J.). Chem. Eng. 65, No. 20, 149-52(1958) Oct. 6.

Charts are presented for evaluating tubeside heat transfer coefficients and pressure drops through the tubes of tubular heat exchangers during streamline flow. (W.L.H.)

**17099**

EASY WAY TO OPTIMUM EXCHANGERS. John Happel (New York Univ.). Chem. Eng. 67, No. 18, 135-7(1958) Sept. 8.

Design of tubular heat exchangers for best economy of operation, employing calculation by incremental costs per sq. ft. exchanger or cooler surface, is discussed. Determination of optimum conditions is made by expressing all variables in terms of a single one, differentiating, and setting the derivatives equal to zero. Basic optimum equations and factors to be included in setting up equations are discussed, along with some pointers and conclusions. (J.R.D.)

**17100**

PREDICTION OF PERFORMANCE CHARACTERISTICS OF HICKMAN-BADGER CENTRIFUGAL BOILER COMPRESSION STILL. LeRoy A. Bromley (Univ. of California, Berkeley). Ind. Eng. Chem. 50, 233-6(1958) Feb.

Equations are derived to predict the operating characteristics of the Hickman-Badger still and the optimum conditions of operation. Included are tables of values for use in performance calculations. (J.R.D.)

**17101**

EFFECT OF MAGNETIC FIELD ON FORCED CONVECTION HEAT TRANSFER IN A PARALLEL PLATE CHANNEL. Robert Siegel (Lewis Flight Propulsion Lab., Cleveland). J. Appl. Mechanics 25, 415-16(1958) Sept.

The fully developed laminar flow of a conducting liquid between two parallel plates under the influence of a transverse magnetic field has been studied. It is shown that the retarding force due to the fluid crossing the magnetic field lines causes the laminar velocity distribution to be more uniform across the channel, similar to that for turbulent flow without a magnetic field. (W.L.H.)

**17102**

DISSIPATION OF ENERGY DUE TO SOLID PARTICLES SUSPENDED IN A VISCOUS LIQUID. Howard Brenner (New York Univ.). Phys. Fluids 1, 338-46(1958) July-Aug.

A general method is developed for calculating the additional mechanical energy dissipation incurred by the presence of solid particles suspended in an incompressible viscous fluid in laminar flow. The development is applicable to flow in any apparatus within which the steady motion of a homogeneous fluid can be described

by omitting the inertial terms in the Navier-Stokes equations or in which the motion occurs in concentric circles. The validity of the results obtained is limited to situations in which the particle dimensions are small compared to those of the apparatus in which the motion is occurring. The technique, based largely upon a reciprocal theorem for the inertialess flow of viscous fluids, is employed to calculate the permanent pressure drop accompanying the passage of liquid through a bed of fluidized solids. When the particles are uniformly distributed throughout the bed, this pressure diminution is equal to the bed weight (corrected for buoyancy) per unit area of duct—in agreement with experimental data on systems in a state of particulate fluidization. Calculations are also presented for the permanent pressure arising from the passage of fluid past an immobilized spherical particle within a cylindrical duct. Einstein's formula for the apparent viscosity of a dilute suspension of spherical particles is also deduced. By means of a new definition of suspension viscosity the heretofore different points of view advanced by Einstein, Jeffery, and Burgers are seen to be consistent with one another. Einstein's result is shown to be independent of the type of viscometer employed provided that the motion of a homogeneous fluid within the device fulfills the previous criteria. In the case of nonspherical particles it is demonstrated that the constant in Einstein's viscosity equation (which has a value of 2.5 for spheres) can never be less than unity, whatever the shape of the rigid particles or their orientation with respect to the axes of the apparatus. (auth)

## Materials Testing

**17103** WADC-TR-57-455
Midwest Research Inst., Kansas City, Mo.
HIGH TEMPERATURE SOLID DRY FILM LUBRICANTS. Period Covered: April 1, 1956 to March 31, 1957. Melvin T. Lavik. 25p. Project Nos. 7331 and 3044. Contract AF33(616)-3684. (AD-150982).

The development and evaluation of a dry lubrication test machine and the testing of several dry film lubricants are discussed. The first part of this program was spent in designing, constructing, and calibrating a device capable of testing dry film lubricants at pressures as high as 50,000 psi and at temperatures up to 800°F. Several minor revisions have been made during the program leading up to the machine. Several commercial dry film lubricants and also some materials prepared at the Institute were investigated for both friction coefficient and wear life at the various temperatures and pressures available with the test machine. In general, the materials worked with, while effecting reasonable lubrication, did not exhibit the wear life which is desired. The lubricant properties of several materials are discussed in this report, with the discussion serving mainly to point out areas in which further information is needed to realize the full benefits available from these materials. (auth)

**17104** WAPD-CTA(EMX)-410
Illinois Inst. of Tech., Chicago. Armour Research Foundation.
WEAR TESTS AT HIGH UNIT BEARING LOADS IN THE 300 TO 1500 PSI LOAD RANGE. Final Report. Dec. 31, 1956. 71p. Project No. B 073. For Westinghouse Electric Corp., Bettis Plant. Contracts NObs-56404, NObs-67500, Subcontract 57B-(04-733). (T-Spec.-551566.) $12.30(ph OTS); $4.50(mf OTS).

Wear rates and coefficients of friction were determined for material combinations in water at 500°F and at room temperature. Tests were conducted at low sliding velocities and at unit bearing loads from 300 to 1500 psi. Nitrided type 304 stainless steel in combination with itself and Stellite 12 are examples of materials showing low wear. (auth)

**17105**
VICKERS-KNOOP HARDNESS CONVERSION. Lloyd Emond (Smith Corp., Milwaukee). Metal Progr. 74, No. 3, 97(1958) Sept.

A series of tests were conducted to determine the relationship of Vickers pyramid hardness numbers and Knoop hardness numbers at loads smaller than the standard 500 grams. Three types of materials were used, a low carbon steel, a high carbon steel drill rod, and Monel metal. The results are tabulated in a chart. (J.R.D.)

## Pumps

*Refer also to abstract 17328.*

**17106** CF-58-8-32
Oak Ridge National Lab., Tenn.
INTERIM REPORT ON DEVELOPMENT OF JET PUMP AND SHROUD AS A RECIRCULATION DEVICE WITHIN THE BLANKET OF A TWO REGION REACTOR VESSEL. J. K. Hayes. Aug. 12, 1958. 39p. Contract [W-7405-eng-26]. $6.30(ph OTS); $3.00(mf OTS).

The feasibility of utilizing a jet pump and a shroud as a recirculation device within the blanket of the proposed reactor pressure vessel for the HRE-3 was examined. A Schute-Koerting designed jet pump was tested in conjunction with a ⅓ scale plastic model consisting of a core vessel, two constant area shrouds, and a blanket vessel. It was concluded that a jet pump with a multinozzle in conjunction with a shroud designed with a sizeable annular flow area provides a very satisfactory recirculation device within the blanket of a two-region reactor pressure vessel. A larger circulating pump head is required, but the fluid flow in the external circuit may be reduced considerably depending on the shroud used. (W.D.M.)

# MINERALOGY, METALLURGY, AND CERAMICS

## Ceramics and Refractories

*Refer also to abstract 17120.*

**17107** BMI-1282
Battelle Memorial Inst., Columbus, Ohio.
DEVELOPMENT OF CERMET FUEL ELEMENTS. Stan J. Paprocki, Donald L. Keller, George W. Cunningham, and Donald E. Kizer. Aug. 11, 1958. Decl. Sept. 26, 1958. 16p. Contract W-7405-eng-92. $3.30(ph OTS); $2.40(mf OTS).

Fabrication techniques for making metal-ceramic fuel elements containing 60 to 90 vol. % of UN or $UO_2$ in a Type 302B stainless steel matrix were investigated. A hot press-forging procedure was most successful for fabricating fuel cores with a density of 90 per cent of theoretical or better. This procedure consisted of sealing the cold-pressed core compacts in stainless steel picture-frame packs, heating to 1900°F, and pressing to a total reduction in thickness of 35%. A

pressure of approximately 50 tsi was used. Specimens produced by this method were evaluated on the basis of their microstructure, modulus of rupture, electrical conductivity, and resistance to thermal shock. Microscopic and macroscopic examination showed the presence of a continuous metal skeleton even in specimens containing 90 vol. % fuel. The modulus of rupture at room temperature varied from 22,500 psi for a specimen containing 63 vol. % $UO_2$ to 9,200 psi for a specimen containing 87 vol. % $UO_2$. Both the electrical conductivity and resistance to thermal shock of $UO_2$ were improved by the addition of a small volume of metal. Gas-pressure-bonding techniques appear promising for cladding these cores into composite elements. (auth)

**17108** AEC-tr-3415

THE PREPARATION OF URANIUM MONOCARBIDE AND ITS REACTIONS WITH CARBIDES OF THE REFRACTORY TRANSITION METALS. H. Nowotny, R. Kieffer, and F. Benesovsky. Translated by Liz Appleby (Hanford Atomic Products Operation) from Rev. mét 55, 453-8(1958). 13p.

The properties of UC investigated were melting point, structure, weight, hardness, and bend resistance. The preparation of the various carbides is discussed. Structure of systems of UC with TiC, ZrC, VC, NbC, TaC, $Cr_3C_2$, $Mo_2C$, WC, and PuC were studied by x-ray methods. (W.D.M.)

**17109** AERE-Lib/Trans-797

THE BINARY SYSTEMS: UC WITH TiC, ZrC, VC, NbC, TaC, $Cr_3C_2$, $Mo_2C$ AND WC. H. Nowotny, R. Kieffer, F. Benesovsky, and E. Lambe. Translated by M. H. Rand (U.K.A.E.A. Atomic Energy Research Establishment) from Monatsh. Chem. 88, 336-43(1957). 9p.

This paper was previously abstracted from the original language and appears in NSA, Vol. 12, as abstract No. 2288.

**17110**

CERAMICS. John W. Lennon (Battelle Memorial Inst., Columbus, Ohio). Ind. Eng. Chem. 50, 1433-7(1958) Sept.

Protection of metals against oxidation, thermal insulation, and electrical insulation at elevated temperatures are among the applications of ceramics. Other developments include information concerning new systems, nuclear fuels, various silicon applications, and ceramic-metal combinations. These new developments and a consolidation of older information are included. (J.R.D.)

**17111**

EFFECT OF HEAT-TREATMENT ON PROPERTIES OF ENAMEL-STEEL COMPOSITES. J. H. Healy and L. K. Breeze (A. O. Smith Corp., Milwaukee and Glascote Products, Cleveland). J. Am. Ceram. Soc. 41, 381-9 (1958) Oct.

The tangential deflection was measured on glass-steel strips that were heat-treated below, as well as in, the transition zone of the glass. The change in tangential deflection after heat treatment was similar to the change in flexure breaking stress, thermal-shock resistance, resistance to fish scaling, and spalling of glass in an acid environment after heat-treatment. (auth)

**17112**

DENSITY STUDIES ON THE FUNCTION OF RARE-EARTH IONS IN GLASS MATRICES. R. C. Vickery and R. Sedlacek (Horizons, Inc., Cleveland). J. Am. Ceram. Soc. 41, 422-6(1958) Oct.

The effect on density of the inclusion of low concentrations of rare-earth ions in lead silicate, soda-lime, and phosphate glass matrices has been studied. Significant changes are noted in these density values that are particularly noticeable in phosphate glasses and least noticeable in lead glasses. It is considered that the variable function of the $Pb^{2+}$ ion obscures the general effect of rare earths in lead silicate glasses; but in soda-lime, and more specifically in phosphate glasses, evidence is highly satisfactory that the lanthanons (La through Lu) function only as network modifiers, and that scandium and yttrium in concentrations of >0.2 and 1.0 atomic % function strongly as network formers. This is shown to be in accord with concepts associating glass function with cation electronegativity. (auth)

**17113**

CERAMIC FABRICATION PROCESSES. W. D. Kingery, ed. Cambridge, Massachusetts Institute of Technology and New York, John Wiley & Sons, Inc., 1958. 245p. $8.00.

Practical experience and scientific knowledge were combined in six general areas of ceramic fabrication processes: slip casting, pressure fabrication, plastic forming, drying and firing, some special processes, and ceramic microstructures. The section on slip casting includes material on ion exchange in clay minerals, rheological properties of aqueous clay systems, preparation and use of plaster molds, controls required and problems encountered in production slip casting, and slip casting nonclay ceramics. Pressure forming of ceramics, controls required and problems encountered in production dry pressing, hydrostatic molding, and an introduction to the vibratory compaction of powders are subjects discussed in the section on pressure fabrication. Discussions on plastic forming included clay-water pastes, particle orientation in clays and whitewares and its relation to forming processes, some experiences with the control of plastic bodies for automatic jiggering, and vertical extrusion of nonclay compositions. In the section on drying and firing, warping and its control, recrystallization and sintering in ceramics, and sintering in the presence of a liquid phase were discussed. The special processes discussed were the hot pressing of ceramics, cementitious bonding, ceramic fabrication, nucleation, and some possible applications of metal-working processes to ceramics and cermets. Effect of microstructure on the electrical and magnetic properties of ceramics and effect of microstructure on the mechanical properties of ceramic materials were discussed in the section on ceramic microstructures. (J.S.R.)

## Corrosion

*Refer also to abstracts 17334 and 17394.*

**17114** AECU-3834

Illinois Inst. of Tech., Chicago. Armour Research Foundation.

CORROSION RESISTANT BRAZING ALLOYS FOR ZIRCALOY. Annual Report [for] May 9, 1955 to May 9, 1956. Joseph B. McAndrew and Harry Schwartzbart. June 1, 1956. 59p. ARF Project B 080. For Westinghouse Electric Corp. Atomic Power Div. Contract AT-11-1-GEN-14, Subcontract 73-(14-401). $9.30(ph OTS); $3.60(mf OTS).

Some forty experimental alloys and a few commercial alloys were used to prepare brazements of simple design for corrosion testing in 680°F water. The materials studied include alloys of Al, Cu, Ni, Pd, Ag, and Zr. (L.T.W.)

**17115** AECU-3836

Illinois Inst. of Tech., Chicago. Armour Research Foundation.

CORROSION RESISTANT BRAZING ALLOYS FOR ZIRCALOY. Final Report [for] May 10, 1956 to July 9, 1957. Robert M. Necheles and Harry Schwartzbart. July 25, 1957. 83p. ARF Project B 080. For Westinghouse Electric Corp. Atomic Power Div. Contract AT-11-1-GEN-14, Subcontract 73-(14-401). $13.80 (ph OTS); $4.80(mf OTS).

More than 60 experimental alloys and a few commercial alloys were used to prepare brazements of simple design for exposure in an autoclave to 600 or 680°F water. Alloys studied include alloys of Cu, Al, Ni, and Zr. (For preceding period see AECU-3834.) (L.T.W.)

**17116** CF-58-8-28

Oak Ridge National Lab., Tenn.

HRP-CPP: DISSOLUTION OF ZIRCONIUM AND STAINLESS STEEL CORROSION PRODUCT OXIDES. J. W. Snider and P. A. Haas. Aug. 5, 1958. 16p. Contract [W-7405-eng-26]. $3.30(ph OTS); $2.40(mf OTS).

Dissolution methods were developed to permit representative sampling of the slurry of corrosion and fission products collected by the HRT chemical processing plant. The procedure selected for HRT-CPP application was to use 15 ml of 10.8 M $H_2SO_4$ per gram of solids with agitation by boiling in a tantalum-lined dissolver. (auth)

**17117** CF-58-8-83

Oak Ridge National Lab., Tenn.

EXAMINATION OF CORROSION SPECIMENS FROM SLURRY BLANKET MOCKUP RUN SM-5. S. A. Reed and E. L. Compere. Aug. 28, 1958. 9p. Contract [W-7405-eng-26]. $1.80(ph OTS); $1.80(mf OTS).

Generally low attack rates were displayed by specimens of type 347 stainless steel, titanium RC-55, and Zircaloy-2 exposed for 1096.5 hr in slurry blanket mockup run SM-5. The leading coupon of type 347 stainless steel suffered more severe attack due to erosive action by the slurry. Specimens of SA-212-B carbon steel displayed attack rates of 230 to 300 mpy. (auth)

**17118** CF-58-8-86

Oak Ridge National Lab., Tenn.

EXAMINATION OF HIGH PRESSURE RECOMBINER LOOP SPECIMENS. M. L. Picklesimer and P. L. Rittenhouse. Aug. 14, 1958. 18p. Contract [W-7405-eng-26]. $3.30(ph OTS); $2.40(mf OTS).

Specimens of iodide zirconium, Zircaloy-2, Zr–15Nb, iodide titanium, TMCA-45 titanium, A-110AT titanium, and 430 stainless steel were corroded in a high-pressure recombiner loop. Analyses were performed to determine the amount of hydrogen pickup. The titanium materials and iodide zirconium showed very high hydrogen pickups, while the zirconium alloys and the 430 stainless steel absorbed smaller amounts of hydrogen. Metallographic examination of the specimens showed that recrystallization occurred in all but the Zr–15Nb specimens. There seems to be little difference in the extent of recrystallization and grain growth whether the specimens were in the boiler section at 230 to 280°C or in the recombiner section at 430 to 500°C. Recrystallization of the boiler samples cannot, at present, be explained or correlated in any way with the amount of hydrogen absorption. Similarly, the amount of hydrogen absorbed cannot be correlated to the amount of corrosion that occurred. Since hydrogen is known to seriously embrittle zirconium and titanium, it is recommended that crystal-bar zirconium and titanium alloys not be used as materials of construction in environments similar to that of the High Pressure Recombiner Loop. (auth)

**17119** CF-58-8-87

Oak Ridge National Lab., Tenn.

REFLECTIONS ON THE HOT-ZONE ATTACK OF INCONEL BY FUSED FLUORIDE. J. L. Scott. Aug. 22, 1958. 18p. Contract [W-7405-eng-26]. $3.30(ph OTS); $2.40(mf OTS).

Evidence is presented that the hot-zone attack of nickel-base alloys in contact with fused fluorides occurs by a grain-boundary diffusion process. Predictions based on the grain-boundary diffusion model are shown to compare favorably with existing data. Certain anomalies are pointed out with regard to the corrosion of Inconel by Fuel No. 30 ($NaF-UF_4-ZrF_4$) and tests which would lead to a better understanding of fused-salt corrosion are outlined. (auth)

**17120** WADC-TR-57-525

Wright Air Development Center. Aeronautical Research Lab., Wright-Patterson AFB, Ohio.

BEHAVIOR OF CERAMIC MATERIALS IN A CORROSIVE SUPERHEATED BORON OXIDE-BORON ENVIRONMENT. Period Covered: January 1957 to August 1957. H. F. Rizzo, B. C. Weber, and M. A. Schwartz. Aug. 1957. 112p. Project title: SURFACE AND INTERFACE PHENOMENA OF MATTER. Task title: REACTIVITY OF SURFACES IN CORROSIVE MEDIA. (AD-131008).

The behavior of a number of ceramic materials in a $B_2O_3-B$ corrosive environment at 1100 and 1315°C is described. Such variables as melt composition and time and temperature of exposure were employed to study the kinetics and reaction mechanisms. A new material, consisting essentially of a Si + B composite, was determined to possess high resistance to the corrosive medium. This new material possessed a high degree of stability in air, under the test conditions employed, and an apparent high strength and thermal shock resistance. (auth)

**17121** NP-tr-144

CORROSION PROBLEMS ARISING FROM THE USE OF WATER AT HIGH TEMPERATURES IN NUCLEAR REACTORS. W. Machu. Translated by S. Fitzgerald (U.K.A.E.A., Atomic Energy Research Establishment) from Atomkern Energie 2, 207-13(1957). 25p.

The numerous problems of physics, chemistry, metallurgy, and engineering arising from the use of water as a coolant or moderator in nuclear reactors operating at high temperatures are considered, with emphasis on the corrosion of metals. Included is a survey of the behavior of the fuels and structural materials in nuclear reactors which are exposed to water or aqueous solutions at temperatures above 100°C. Corrosive elements and conditions are discussed, and methods of reducing corrosion are examined. The behavior of uranium and its alloys under corrosion in water are characterized, and the properties of thorium and its alloys are examined. (J.R.D.)

**17122**

HOW ENVIRONMENT DIRECTS CORROSION CONTROL. Robert V. Jelinek (Syracuse Univ., N. Y.). Chem. Eng. 65, No. 19, 163-8(1958) Sept. 22.

A general discussion of the cause and inhibition of corrosion is presented. The considerations include the effect of Ph in relation to oxygen concentration, protective films, hydrogen overvoltage, and metal ion concentration. In addition, the effects of oxidizing agents, temperature effects, stream velocity effects, biological influences, and the effects of light are examined. The

functions of inhibitors are discussed, pointing out that selection for a particular system is largely trial and error. Finally, the applications of cathodic protection are described. (J.R.D.)

**17123**

PROCESSES OF ELECTROCHEMICAL CORROSION. G. W. Akimov. Corrosion 14, 463-83t(1958) Oct.

Theoretical considerations involved in determining the potential of hydrogen and oxygen electrodes are reviewed briefly. Overvoltage is discussed in detail. The various connected stages involved in the process of the passage of ions into solution are outlined. Use is made of the Evans diagram for real processes. In making the study of processes with hydrogen depolarization it was found convenient to use a model of a microelement. A comparison of experimental data obtained with models and from deductions from the Evans diagrams indicates that there was a complete agreement between the theory and experiment for processes with hydrogen depolarization. Considerable attention was given to the factors affecting the rate of oxygen diffusion to the metal in view of the fact that the rate of corrosion processes with oxygen depolarization is determined mostly by the rate of oxygen diffusion toward the metal surface. A model was used to examine the part played by the electrical resistance of a cell with oxygen depolarization. It was found that it was only when the resistance became very large and the potential difference was close to the initial value that the current started to decrease. Experiments showed also that changing the anodic material did not influence the rate of the cathodic process when it was controlled by the rate of oxygen diffusion to the cathode. The theory of microcells is examined in detail and a review made of some of the experimental data for processes with hydrogen depolarization. The influence of alloying elements on corrosion rates of metals in various media is discussed. A number of explanations are offered to show why the regularities observed on models are not applicable to corrosion of microelements. The "different effect" is discussed in connection with corrosion processes having hydrogen depolarization. Other topics considered include electrochemical cells with differential aeration, corrosion processes in a moisture film, and atmospheric corrosion. (auth)

**17124**

PROTECTIVE COATINGS. Francis Scofield (National Paint, Varnish and Lacquer Assn.). Ind. Eng. Chem. 50, 1479-81(1958) Sept.

Recently, great emphasis has been placed on relatively new materials as binders for coatings, the greatest interest being in epoxy resins. Other coatings of interest are polyurethanes, various elastomers, and polyesters. A review of the properties and uses of these and various other new coatings is presented. (J.R.D.)

**17125**

SULFURIC ACID CORROSION OF STAINLESS STEELS. W. L. Mathay (U. S. Steel Corp.). Ind. Eng. Chem. 50, No. 9, 85A-6A(1958) Sept.

To obtain the greatest economic advantage from the use of stainless steel in the chemical industry, the environment and design of equipment in which the steels are used must be properly selected. The chromium–nickel austenitic steel depend on a passive film on the surface for corrosion resistance to dilute sulfuric acid. Oxidizing agents in sulfuric acid promote the corrosion resistance of these steels; however, it is necessary that the oxidizers have free access to the metal surface continuously. Methods of evaluating steels for various purposes, including laboratory and plant equipment, are discussed. (J.R.D.)

**17126**

SELECTIVE OXIDATION OF Al FROM AN Al–Fe ALLOY. Richard E. Grace (Purdue Univ., Lafayette, Ind.) and Alan U. Seybolt (General Electric Co., Schenectady, N. Y.). J. Electrochem. Soc. 105, 582-5 (1958) Oct.

The selective oxidation of aluminum from a 4.8 wt. % Al–Fe alloy was studied with a microbalance at temperatures of 700 to 900°C. The oxidizing gas was damp $H_2$, with dewpoints ranging from −55 to 0°C. The oxidation product was identified by electron diffraction to be the crystalline spinel, $\gamma$-$Al_2O_3$. At 800°C the parabolic oxidation constant was approximately proportional to the $\frac{1}{4}$th power of the $H_2O/H_2$ gas ratio, and the experimental activation energy for the over-all oxidation reaction with 0°C dewpoint hydrogen gas was 72 kcal/mole. (auth)

**17127**

THE CORROSION OF 2¼% Cr – 1% Mo STEEL BY LIQUID BISMUTH. G. W. Horsley and J. T. Maskrey (Atomic Energy Research Establishment, Harwell, Berks, Eng.). J. Iron Steel Inst. (London) 189, Part 2, 139-48(1958) June.

The dynamic corrosion of 2¼% Cr–1% Mo silicon-killed steel super-heater tubing by liquid bismuth has been studied in thermal convection loops working with maximum temperatures up to 625°C, temperature gradients up to 150°C, and fluid velocities of 3 to 4 mm/s. Under these conditions the rate at which the steel is corroded by pure bismuth is at least 0.65 in./year. The effect of adding 250 to 500 ppm Zr to the bismuth as an inhibitor on the corrosion of the steel has been studied. This inhibitor plates out on the steel mainly as a film of zirconium nitride and temporarily prevents attack by bismuth, reducing the corrosion rate to about 0.17 in./year. The film however occasionally spalls off and is not reformed; under this condition intergranular corrosion of the underlying steel proceeds rapidly. If the steel is heavily nitrided (~1% N) its rate of corrosion by inhibited bismuth is reduced to a maximum of 0.010 in./year, the nitride film reforms if broken, and intergranular penetration is prevented. The effect of pile radiation in BEPO on the corrosion of the steel by inhibited bismuth has also been studied. It has no beneficial effect and may even considerably reduce the corrosion resistance of the steel and the efficiency of the inhibitor. (auth)

**17128**

CORROSION OF ZIRCALOY-2 SHEET WELDMENTS. R. Stein and R. E. Monroe (Battelle Memorial Inst., Columbus, Ohio). Welding J. (N. Y.) 37, 468s-72s (1958) Oct.

Studies of fabrication and welding procedures for reactor fuel elements consisting of $UO_2$ plates jacketed in Zircaloy-2 sheet were conducted. Emphasis was placed on determining the suitability of economic welding techniques for joining Zircaloy-2. Comparison of bend ductility and corrosion properties showed no differences in weldments made in air with inert-gas shielding and weldments made in an inert-gas-filled vacuum-purged dry box. Weight gains of all corrosion samples were about the same. Fabrication, property, and procedure data are reported. (auth)

## Geology and Mineralogy

**17129** TEI-516

Geological Survey, Washington, D. C.

MINERALOGY AND GEOLOGY OF THE VANADIUM-URANIUM DEPOSIT OF THE RIFLE AND GARFIELD

MINES, GARFIELD COUNTY, COLORADO. Theodore Botinelly and R. P. Fischer. Oct. 1955. 21p. $4.80 (ph OTS); $2.70(mf OTS).

The vanadium–uranium deposit at the Rifle and Garfield mines is in the Wingate(?) sandstone and the overlying Entrada sandstone. Both formations are composed of clean, light-colored, fine-grained, massive, and crossbedded sandstone. The ore, which consists of vanadium with only a small uranium content, occurs in fine-grained minerals that impregnate the sandstone. It forms three partly overlapping layers, each of which is tabular and lies generally parallel to the major bedding. Each vanadium layer is bordered on one side by a thin band of finely disseminated galena and clausthalite, beyond which is a greenish layer containing a chromium-bearing mineral. The galena band and the chromium-bearing layer lie above the lower and upper vanadium layers but below the middle vanadium layer. Primary ore minerals of the vanadium layer are roscoelite and a small amount of vanadium-bearing chlorite and montroseite. Base metal sulfides are sparse in the ore but abundant in the galena band. Oxidation has not affected the roscoelite appreciably; montroseite and perhaps vanadium-bearing chlorite have oxidized to form secondary vanadium minerals. A little carnotite is present in the oxidized parts of the deposit, but primary uranium minerals have not been recognized. The deposit is similar to vanadium–uranium deposits of the Plateau but is unique in the high ratio of vanadium to uranium, the lack of carbonaceous material, and the abundance of roscoelite. (auth)

**17130**

PRELIMINARY STUDY OF THE RADIOACTIVE WEATHERING ZONE OF THE PEGMATITE OF KOBO-KOBO (KIVU) (BELGIAN CONGO). L. Van Wambeke (Centre d'Etude Nucleaire, Mol-Donk, Belgian Congo). Bull. soc. geol. Belg. 66, 268-76(1957). (In French)

The weathering zone of the pegmatite of Kobokobo (Kivu) is locally characterized by a quite high radioactivity (mean value 0.5% $U_3O_8$). This radioactivity is due to minute particles of a secondary uranium mineral dispersed between oxides (goethite and lithiophorite) and between the phosphates. Uranium and aluminum fluorescent phosphates, ceruleolactite, and evansite are closely associated. The last mineral shows a very high uranium content (more than 6% $U_3O_8$). (auth)

**17131**

SOME PROPERTIES OF MIXED GARNETS OF GADOLINIUM-ERBIUM AND OF GADOLINIUM-YTTRIUM. Gérard Villers, Jean Loriers, and Colette Claudel. Compt. rend. 247, 710-13(1958) Aug. 25. (In French)

The values of the parameters of the crystalline lattice, the Curie points, and the compensation points of mixed garnets of gadolinium–erbium and gadolinium–yttrium are given. The variation of the compensation points of these garnets is justified. (tr-auth)

**17132**

EVALUATION OF URANIUM ORE GUIDES, MONUMENT VALLEY, ARIZONA AND UTAH. Charles G. Evensen and Irving B. Gray (U. S. Atomic Energy Commission, Grand Junction, Colo.). Econ. Geol. 53, 639-62(1958) Sept.-Oct.

In Monument Valley of Arizona and Utah, on the southern end of the Monument upwarp, exposed sedimentary rocks range in age from Pennsylvanian to Jurassic, and are intruded by Pliocene (?) dikes and volcanic necks. Uranium occurs chiefly in and immediately below paleochannels cut into the Triassic Moenkopi formation and filled with sediments of the Shinarump member of the Triassic Chinle formation. Most ore occurs in local scours along these channel courses. Within the channels and scours, uranium deposits appear to have been controlled largely by permeability. Marked increases in argillaceous content form impermeable barriers that localize a number of ore bodies. These barriers may be either argillaceous material within the Shinarump paleochannel sediments, or the steep channel flanks of Moenkopi mudstone. Carbonaceous material may have been a factor in development of an environment favorable to precipitation. Primary uranium deposits in Monument Valley consisted largely of coffinite, uraninite, montroseite, and copper and iron sulphides. During oxidation, uranium and vanadium combine to form relatively insoluble carnotite-type minerals. Copper is migratory and generally is deposited in carbonates. In a few places copper-carbonates appear in halos surrounding uranium-vanadium ore bodies. Changes of color occur in the upper Moenkopi clastics in and around areas of more intense mineralization. Thickness of the zone of apparent color changes is extremely variable, apparently controlled by both intensity of mineralization and quantity of argillaceous material in superjacent Shinarump sediments. (auth)

**17133**

PHOTOGEOLOGIC MAP OF THE ESCALANTE FORKS QUADRANGLE MESA, MONTROSE AND DELTA COUNTIES, COLORADO. MISCELLANEOUS GEOLOGIC INVESTIGATIONS MAP I-274. R. J. Hackman. Washington, U. S. Geological Survey, 1958. $0.50.

## Metals and Metallurgy

*Refer also to abstracts 17281, 17282, 17283, 17284, 17285, 17287, 17288, 17290, 17291, 17293, 17294, 17295, 17298, 17299, 17303, 17304, 17308, 17309, 17313, 17332, 17333, 17361, 17362, 17363, 17398, 17406, 17410, 17411, 17412, 17436, 17437, 17439, and 17952.*

**17134** AECU-3835

Illinois Inst. of Tech., Chicago. Armour Research Foundation.

JOINING OF ZIRCONIUM TO STAINLESS STEEL. Final Report. Joseph B. McAndrew and Harry Schwartzbart. Jan. 22, 1957. 127p. ARF Project B 081. For Westinghouse Electric Corp. Atomic Power Div. Contract [AT-11-1-GEN-14], Subcontract 73-(04-753). $19.80(ph OTS); $6.30(mf OTS).

The objective of this project was to develop methods and materials for joining zirconium to stainless steel for service in high temperature water. A joint in heavy wall tubing incorporating a metallurgical seal was specifically required. Flash welding and brazing were experimentally investigated. A variety of brazing alloys was used, including a few common alloys and many unconventional ones devised specifically for this purpose. Some weldments and brazements showed promise of meeting the requirements, but reproducibility of performance was poor in both cases. Thermally engendered stresses proved to be a major source of difficulty. (auth)

**17135** BLG-18

Brussels. Centre D'Étude de l'Énergie Nucleaire.

CONTRIBUTION A L'ETUDE DE LA PREPARATION DU ZIRCONIUM ET DE CERTAINS DE SES ALLIAGES PAR REDUCTION METALLOTHERMIQUE. (Contribution to the Study of the Preparation of Zirconium and

Some of its Alloys by Metallothermic Reduction). C. Decroly, J. Gerard, and D. Tytgat. May 3, 1958. 61p.

A direct process for preparing zirconium, Zircaloy, and other alloys in massive form by calcium reduction is described. Zirconium tetrafluoride is reduced in the presence of the alloying metals. The yield is excellent even if no booster is used. However, it is necessary to use calcium with a low oxygen content to obtain ductile ingots. Details on a method for purifying zirconium tetrafluoride are given. Theoretical considerations on metallothermic reactions are discussed. Some experimental techniques are discussed. (auth)

**17136** BMI-1007
Battelle Memorial Inst., Columbus, Ohio.
EVALUATION AND CONSOLIDATION OF ELECTROLYTIC THORIUM. Henry A. Saller, Ronald F. Dickerson, and Ellis L. Foster. June 15, 1955. Decl. June 13, 1956. 29p. Contract W-7405-eng-92. $4.80(ph OTS); $2.70(mf OTS).

Sound, fabricable ingots of thorium were produced to triple arc melting of electrolytic thorium. Consumable electrodes were fabricated by tack welding of cold-pressed and vacuum-sintered bars of the granular thorium electrodeposited from a molten-salt bath. The hydrogen content of the electrodeposited material was reduced from 80 to 4 ppm by vacuum sintering at 1250°C at pressures below $1 \times 10^{-3}$ mm of mercury. Both sodium and chlorine contents were reduced during melting; sodium from 250 to 25 ppm and chlorine from 1000 to 30 ppm. Oxygen and HCl acid-insoluble contents increased during sintering and melting. Oxygen content increased from 0.35 to 0.50 wt. % and HCl acid-insoluble content from 0.8 to 4.0 wt. %. A starlike inclusion revealed by metallographic examination of the as-cast thorium was identified as $ThO_2$. (auth)

**17137** BMI-1276
Battelle Memorial Inst., Columbus, Ohio.
THEORETICAL STUDIES OF THE SOLIDIFICATION OF URANIUM CASTINGS. Billie L. Fletcher, Ellis L. Foster, Jr., Charles K. Franklin, Andrew Lechler, Benjamin L. Schwartz, and Ronald F. Dickerson. July 11, 1958. Decl. Sept. 18, 1958. 48p. Contract W-7405-eng-92. $7.80(ph OTS); $3.30(mf OTS).

The evaluation of factors involved in the production of sound uranium castings is the objective of a program of study now in progress. A mathematical model has been developed to calculate the time-temperature relationships in a cylindrical uranium casting during its solidification. Finite-difference equations are used, and the solution is obtained by use of a digital computer. Studies of the effects of such variables as the superheat, rate of pour, mold preheat, mold size, and others are possible, and their effect on casting soundness can be determined. Initial computed results demonstrate that this approach is feasible, and experiments are proposed to verify the method of analysis. The need for accurate values of the thermal properties of the casting and mold material is indicated. (auth)

**17138** DMIC-46D
National Research Council. Materials Advisory Board.
UNIFORM TESTING PROCEDURES FOR SHEET MATERIALS. Sept. 12, 1958. 39p. (AD-201871; PB-121649).

The contents of this report have been published previously as MAB-118-M; MAB-121-M; MAB-122-M; MAB-130-M.

This report was issued by Defense Metals Information Center, Battelle Memorial Inst. under Contract AF18 (600)-1375.

A broad description of the types of design data to be collected as part of the titanium sheet-rolling program is presented. Uniform testing procedure for tension, compression, bearing, shear, and crippling tests are given. (W.D.M.)

**17139** HW-56513
General Electric Co. Hanford Atomic Products Operation, Richland, Wash.
PRELIMINARY DATA ON U/Ni/X-8001 ALUMINUM ALLOY DIFFUSION. D. R. Green. June 20, 1958. Decl. Sept. 30, 1958. 31p. Contract W-31-109-Eng-52. $4.80(ph OTS); $2.70(mf OTS).

The rate of diffusion of uranium toward the outer surface of X-8001 aluminum alloy through a nickel diffusion barrier was determined. Effects of the original nickel barrier thickness, and of the annealing time and temperature were studied. The rate of diffusion of aluminum into nickel from the original Al/Ni interface, as a function of time and temperature, was also determined. (auth)

**17140** MAB-127-M-1
National Research Council. Materials Advisory Board.
INTERIM RECOMMENDATIONS FOR HEAT TREATMENT OF DOD TITANIUM SHEET ROLLING ALLOYS. First Report by Subpanel on Heat Treatment. First Revision. Sept. 10, 1958. 14p. Contract DA-36-039-sc-76436.

This report supersedes MAB-127-M.

Heat treatment procedures for the alloys Ti–6 Al–4V, Ti–4 Al–Mo–1V, and Ti–2.5 Al–16V are outlined. (J.E.D.)

**17141** NMI-4358
Nuclear Metals, Inc., Cambridge, Mass.
POWER REACTOR PROGRAM. Progress Report to E. I. du Pont de Nemours and Company for the Period January 26, 1958 through February 20, 1958. J. L. Klein, S. Isserow, P. D. Corzine, A. M. White, D. F. Kaufman, R. G. Jenkins, and S. R. Maloof. Mar. 6, 1958. 52p. CONTRACT AT(30-1)-1565, Sponsor Agreement No. S-31. $9.30(ph OTS); $3.60(mf OTS).

Progress in production of Zircaloy-2 clad U–2% Zr tubular fuel elements is reported. Analysis and corrosion testing of Zircaloy-2 forging stock continued. Destructive testing of end seals is described. Developments in extrusion techniques and billet shapes are reported. Corrosion testing of defected samples continues. (See also NMI-4356.) (T.R.H.)

**17142** TID-5061(Del.)
Oak Ridge National Lab., Tenn.
PROCEEDINGS OF THE METALLURGY AND MATERIALS INFORMATION MEETING, APRIL 16-18, 1951, HELD AT OAK RIDGE, TENNESSEE, SPONSORED BY OAK RIDGE NATIONAL LABORATORY. VOLUME I. Decl. with deletions Mar. 7, 1957. 588p. $100.80(ph OTS); $11.10(mf OTS).

At seven formal technical sessions, fifty-three papers on fundamental and developmental research on reactor materials were presented under the following categories: reactor development, physical metallurgy, reduction and refining, melting and fabricating, powder metallurgy, and high-temperature materials. All but a few of the papers are included in this volume. Separate abstracts have been prepared for each paper. (W.L.H.)

**17143** TID-5061(Del.)(p.15-23)
Division of Reactor Development, AEC.
REACTOR DEVELOPMENT PROBLEMS OF THE FUTURE. George L. Weil. p.15-23 [of] PROCEEDINGS OF THE METALLURGY AND MATERIALS INFORMATION MEETING, APRIL 16–18, 1951, HELD AT OAK

RIDGE, TENNESSEE, SPONSORED BY OAK RIDGE NATIONAL LABORATORY. VOLUME I (deleted). 9p.

Reactor development problems of the future will probably differ only slightly from reactor development problems of today. Both are primarily problems of materials. Whether we are developing new reactors to meet specific needs or whether we are developing reactors with improved performance, the limitations on design usually wind up as problems of availability and knowledge of materials that can go into the reactors. Some of the problems and objectives in developing specific reactors are also discussed. (W.L.H.)

**17144** TID-5061(Del.)(p.24-33)
[Division of Research, AEC.]
MATERIALS DEVELOPMENT PROBLEMS OF THE FUTURE. D. W. Lillie. p.24-33 [of] PROCEEDINGS OF THE METALLURGY AND MATERIALS INFORMATION MEETING, APRIL 16-18, 1951, HELD AT OAK RIDGE, TENNESSEE, SPONSORED BY OAK RIDGE NATIONAL LABORATORY. VOLUME I (deleted). 10p.

A brief review of the current and possible future materials development problems is presented. The current problems of Th, Pu, Be, Zr, graphite, and ceramics are discussed in greater detail. (W.L.H.)

**17145** TID-5061(Del.)(p.35)
Oak Ridge National Lab., Tenn.
ORNL REACTOR DEVELOPMENT PROGRAM. J. A. Swartout. p.35 [of] PROCEEDINGS OF THE METALLURGY AND MATERIALS INFORMATION MEETING, APRIL 16-18, 1951, HELD AT OAK RIDGE, TENNESSEE, SPONSORED BY OAK RIDGE NATIONAL LABORATORY. VOLUME I (deleted). 1p.

Significant progress and changes have occurred in the ORNL reactor development program since a review was presented at the meeting of April 16, 1951. The review, therefore, is not presented in this report but references are given to pertinent documents which show the progress and program of the ORNL reactor development program. (W.L.H.)

**17146** TID-5061(Del.)(p.42-56)
Brookhaven National Lab., Upton, N. Y.
TESTING OF BNL FUEL CARTRIDGES. J. E. Atherton and D. H. Gurinsky. p.42-56 [of] PROCEEDINGS OF THE METALLURGY AND MATERIALS INFORMATION MEETING, APRIL 16-18, 1951, HELD AT OAK RIDGE, TENNESSEE, SPONSORED BY OAK RIDGE NATIONAL LABORATORY. VOLUME I (deleted). 15p.

The effect of thermal-cycling BNL fuel elements is discussed. The elongation and volume measurements of these cartridges are given. Creep data show BNL cartridges will stand up at 350°C for more than ten years. (W.L.H.)

**17147** TID-5061(Del.)(p.57-8)
Oak Ridge National Lab., Tenn.
TESTING OF MTR FUEL ELEMENT. O. Sisman. p.57-8 [of] PROCEEDINGS OF THE METALLURGY AND MATERIALS INFORMATION MEETING, APRIL 16-18, 1951, HELD AT OAK RIDGE, TENNESSEE, SPONSORED BY OAK RIDGE NATIONAL LABORATORY. VOLUME I (deleted). 2p.

The stability of an MTR fuel element under operating conditions was determined by irradiating in the central thimble of the Chalk River Reactor. Of principle concern are dimensional changes and warpage or twisting of the assembly due to radiation damage. The test was designed to show whether the life of the fuel element is dictated by radiation damage or fuel burn-up. The results indicate that the life of the fuel elements will indeed be dictated by fuel burn-up, as one would hope. (auth)

**17148** TID-5061(Del.)(p.61-72)
[Knolls Atomic Power Lab., Schenectady, N. Y.].
GROWTH AND CRYSTALLOGRAPHY OF DEFORMATION OF BETA PHASE URANIUM SINGLE CRYSTALS. A. N. Holden. p.61-72 [of] PROCEEDINGS OF THE METALLURGY AND MATERIALS INFORMATION MEETING, APRIL 16-18, 1951, HELD AT OAK RIDGE, TENNESSEE, SPONSORED BY OAK RIDGE NATIONAL LABORATORY. VOLUME I (deleted). 12p.

Over the past two years, several beta-phase U single crystals have been grown and retained in a metastable condition at room temperature. Only recently has it been possible to grow excellent beta-phase crystals with every attempt. The present method is described. With their availability, it has been possible to negate a long-standing conclusion that the beta phase was completely brittle. The crystals are usually ductile and deform by slip. The slip plane has been identified as the [110] type plane in the beta crystal and the direction of slip as the <001> direction. Only when they are unfavorably oriented do beta crystals behave in a brittle fashion. (W.L.H.)

**17149** TID-5061(Del.)(p.73-98)
Argonne National Lab., Lemont, Ill.
QUANTITATIVE DETERMINATION OF THE ROLLING AND RECRYSTALLIZATION TEXTURE OF A 300°C ROLLED URANIUM ROD. W. P. Chernock and P. A. Beck. p.73-98 [of] PROCEEDINGS OF THE METALLURGY AND MATERIALS INFORMATION MEETING, APRIL 16-18, 1951, HELD AT OAK RIDGE, TENNESSEE, SPONSORED BY OAK RIDGE NATIONAL LABORATORY. VOLUME I (deleted). 26p. (ANL-FF-209g).

The rolling and recrystallization texture of a 300°C-rolled U rod was investigated employing the Geiger counter spectrometer and a modification of the Schulz technique. Specimen preparation was such that reported limitations of the Schulz reflection technique were eliminated. A comparison of textures in the as-rolled condition and after recrystallization is presented. A change in the rolling texture is observed upon recrystallization at 575°C. (auth)

**17150** TID-5061(Del.)(p.111-15)
Battelle Memorial Inst., Columbus, Ohio.
LATEST RESULTS ON URANIUM ALLOY SYSTEMS. H. A. Saller and F. A. Rough. p.111-15 [of] PROCEEDINGS OF THE METALLURGY AND MATERIALS INFORMATION MEETING, APRIL 16-18, 1951, HELD AT OAK RIDGE, TENNESSEE, SPONSORED BY OAK RIDGE NATIONAL LABORATORY. VOLUME I (deleted). 5p. (BMI-85).

The latest results on the uranium alloy systems are reviewed. In particular a U-Mo equilibrium diagram, a U–Nb constitutional diagram, and a U-V constitutional diagram are given. (W.L.H.)

**17151** TID-5061(Del.)(p.117-45)
Knolls Atomic Power Lab., Schenectady, N. Y.
TRANSFORMATION KINETICS IN URANIUM–CHROMIUM ALLOYS. Donald W. White, Jr. p.117-45 [of] PROCEEDINGS OF THE METALLURGY AND MATERIALS INFORMATION MEETING, APRIL 16–18, 1951, HELD AT OAK RIDGE, TENNESSEE, SPONSORED BY OAK RIDGE NATIONAL LABORATORY. VOLUME I (deleted). 29p.

The kinetics of transformation of beta U to alpha U in alloys containing 0.3, 0.6, 1.8, and 4.0 at.% Cr have been determined and the data analyzed and presented in graphical form. The nature of the transformation in the

two higher alloys is similar and is represented by single C-shaped curves in the time-temperature-transformation (T-T-T) diagrams. The T-T-T diagrams. The T-T-T diagrams of the two lower Cr alloys display double C's, where in the lower-temperature C represents a second type of transformation. The lower C extends over a broader temperature range in the 0.3% alloy than in the 0.6% alloy, and it is proposed that pure U transforms entirely by the mechanism of the lower C, U-Cr alloys can be heat-treated by the method of isothermal transformation to obtain small grain size and to provide dimensional and surface stability when thermally cycled. The optimum temperature range on the T-T-T diagram in which these alloys can be heat-treated isothermally is in the lower portion of the upper C. (auth)

**17152** TID-5061(Del.)(p.146-53)
Battelle Memorial Inst., Columbus, Ohio.
GRAIN REFINEMENT OF URANIUM BY ALLOYING. H. A. Saller, J. R. Keeler, and N. S. Eddy. p.146-53 [of] PROCEEDINGS OF THE METALLURGY AND MATERIALS INFORMATION MEETING, APRIL 16-18, 1951, HELD AT OAK RIDGE, TENNESSEE, SPONSORED BY OAK RIDGE NATIONAL LABORATORY. VOLUME I (deleted). 7p. (BMI-87(Del.)).

A brief review of the methods of grain refinement of U by alloying is given. Included are microphotographs showing the crystalline structure of the U alloys and a schematic drawing of a melting furnace used in the induction melting of the alloys. (W.L.H.)

**17153** TID-5061(Del.)(p.157-65)
Argonne National Lab., Lemont, Ill.
MELTING AND REFINING OF HIGH PURITY URANIUM. B. Blumenthal. p.157-65 [of] PROCEEDINGS OF THE METALLURGY AND MATERIALS INFORMATION MEETING, APRIL 16-18, 1951, HELD AT OAK RIDGE, TENNESSEE, SPONSORED BY OAK RIDGE NATIONAL LABORATORY. VOLUME I (deleted). 9p. (ANL-FF-5J).

A brief review is given of the processes and procedures used at ANL to convert the high-purity electrolytic U crystals into sound ingots suitable for working or other manufacturing processes. The method produces U ingots which are better than 99.994% pure. (W.L.H.)

**17154** TID-5061(Del.)(p.166-71)
Ames Lab., Ames, Iowa.
A REVIEW OF THE AMES PROCESS FOR PRODUCING THORIUM METAL. H. A. Wilhelm. p.166-71 [of] PROCEEDINGS OF THE METALLURGY AND MATERIALS INFORMATION MEETING, APRIL 16-18, 1951, HELD AT OAK RIDGE, TENNESSEE, VOLUME I (deleted). 6p.

A brief review is given of the Ames process for producing Th metal. The processes start with mantle grade thorium nitrate tetrahydrate; this is converted to thorium oxalate which is calcined to the oxide. The oxide is converted to the fluoride and this salt is reduced to metallic Th by Ca metal in the presence of Zn. A Th-Zn alloy is obtained in massive form. A Zn removal step is subsequently employed and the resulting dezinced metal is melted and cast into one of several possible forms. The ingot is cropped, surface cleaned, and often cut into short lengths. The resulting billets are numbered and boxed for shipment. (W.L.H.)

**17155** TID-5061(Del.)(p.172-8)
Ames Lab., Ames, Iowa.
RECENT IMPROVEMENTS IN THE PREPARATION OF ZIRCONIUM BY BOMB REDUCTION. H. A. Wilhelm and K. A. Walsh. p.172-8 [of] PROCEEDINGS OF THE METALLURGY AND MATERIALS INFORMATION MEETING, APRIL 16-18, 1951, HELD AT OAK RIDGE, TENNESSEE, SPONSORED BY OAK RIDGE NATIONAL LABORATORY. VOLUME I (deleted). 7p.

The application of the Ames process for the reduction of $ZrF_4$ with Ca was made on an experimental scale. From this reduction, Zr is recovered in the massive form as an alloy containing Zn. The experimental biscuits are vacuum melted in graphite to remove Ca and Zn. An addition of Zn metal turnings in the reduction charge is made to lower the melting point of the metallic phase. To compensate for the heat losses which occur during the reduction, iodine is added to the reduction charge to supplement the exothermic heat of reaction. The Ca iodide formed in this thermal "booster" reaction also serves to lower the melting point of the slag phase. The corrosion rates of Zr–Sn alloys are also reported. (auth)

**17156** TID-5061(Del.)(p.179-95)
Westinghouse Electric Corp. Atomic Power Div., Pittsburgh.
THE PREPARATION OF ZIRCONIUM BY THE DEBOER PROCESS. Z. M. Shapiro. p.179-95 [of] PROCEEDINGS OF THE METALLURGY AND MATERIALS INFORMATION MEETING, APRIL 16-18, 1951, HELD AT OAK RIDGE, TENNESSEE, SPONSORED BY OAK RIDGE NATIONAL LABORATORY. VOLUME I (deleted). 17p. (WAPD-TD-35).

The DeBoer process for the reduction of Zr involving the thermal decomposition of the iodide is described. The iodide decomposition method is inherently more expensive than the Kroll process at the present time because it uses sponge as a starting material, but it produces a beautiful, consolidated mass of material—crystal bar—which is very ductile, easily handled, worked, and arc-melted. What is most important, however, is the fact that when made under the proper conditions, crystal bar has excellent corrosion resistance in 65°F water. (W.L.H.)

**17157** TID-5061(Del.)(p.197-208)
Brush Beryllium Co., Cleveland.
PRODUCTION OF BERYLLIUM PARTS FOR THE MATERIALS TESTING REACTOR. Charles Baldwin Sawyer. p. 197-208 [of] PROCEEDINGS OF THE METALLURGY AND MATERIALS INFORMATION MEETING, APRIL 16–18, 1951, HELD AT OAK RIDGE, TENNESSEE, SPONSORED BY OAK RIDGE NATIONAL LABORATORY. VOLUME I (deleted). 12p.

A brief review of the reduction processes necessary for the production of Be for parts used in the MTR is given. Two condensed flowsheets of the processes employed and photographs of the machined Be are included. (W.L.H.)

**17158** TID-5061(Del.)(p.209-14)
Massachusetts Inst. of Tech., Cambridge.
PURIFICATION OF CLIFTON FLAKE BERYLLIUM. C. S. Pearsall. p.209-14 [of] PROCEEDINGS OF THE METALLURGY AND MATERIALS INFORMATION MEETING, APRIL 16-18, 1951, HELD AT OAK RIDGE, TENNESSEE, SPONSORED BY OAK RIDGE NATIONAL LABORATORY. VOLUME I (deleted). 6p.

Clifton flake beryllium after removal of the chloride is in general better with respect to purity than QMV Be powders. There is considerable improvement in the oxygen content. On the other hand, QMV Be is lower in Cu, while the C content occurs in about the same amount in both metals. Only three samples of drip-melted Clifton flake out of nine samples tested indicated any

corrosion resistance. No sample has run for more than 260 hours at this time so that final evaluation of the corrosion results cannot be made for 500 to 1000 hours. The better corrosion results obtained with the lower-purity QMV Be metal cannot be explained on the basis of the information now available. (W.L.H.)

**17159** TID-5061(Del.)(p.215-22)
Ames Lab., Ames, Iowa.
PREPARATION OF SOME PURE RARE EARTH METALS. Adrian H. Daane and F. H. Spedding. p.215-22 [of] PROCEEDINGS OF THE METALLURGY AND MATERIALS INFORMATION MEETING, APRIL 16-18, 1951, HELD AT OAK RIDGE, TENNESSEE, SPONSORED BY OAK RIDGE NATIONAL LABORATORY. VOLUME I (deleted). 8p.

As a consequence of the successes in this laboratory in the preparation of U and Th by the reduction of their halides with Ca and Mg, this process was employed to prepare over one half ton of Ce metal of >95% purity (balance, other rare earths) which was used primarily for the preparation of Ce sulfide crucibles by other AEC laboratories. The metal was made by packing a mixture of anhydrous Ce chloride, Ca, and I in a refractory oxide-lined steel bomb, and firing this mixture at a temperature of about 650°C. The reactions of Ce chloride and of I, and particularly the latter, with Ca are sufficiently exothermic to fuse all of the reaction products in the bomb and allow collection of the Ce metal in the bottom of the bomb. This metal contained about 2% Ca, and a vacuum remelting or casting operation in refractory oxide containers at about 1200°C eliminated all but about 200 ppm of the Ca. This same technique was used to prepare kilogram lots of La, Pr, and Nd. (W.L.H.)

**17160** TID-5061(Del.)(p.225-34)
[Argonne National Lab., Lemont, Ill.].
THE EFFECT OF CYCLING VARIABLES UPON THE GROWTH RATE OF 300°C ROLLED URANIUM. R. M. Mayfield. p.225-34 [of] PROCEEDINGS OF THE METALLURGY AND MATERIALS INFORMATION MEETING, APRIL 16-18, 1951, HELD AT OAK RIDGE, TENNESSEE, SPONSORED BY OAK RIDGE NATIONAL LABORATORY. VOLUME I (deleted). 10p. (ANL-FF-65h).

The magnitude of permanent dimensional changes that result from thermal-cycling of 300°C-rolled U in the alpha temperature range is affected by the cycling variables. (1) The higher the upper temperature, with a constant lower temperature, the greater the resulting growth. (2) A constant growth rate is approached with increased holding times at the higher temperature levels. The higher the temperature the shorter the holding time required. (3) The growth rate increases nearly linearly with increasing temperature range at a given constant upper temperature. The higher the upper temperature of the range, the higher the growth rate. (100 to 400°C versus 300 to 600°C.) (4) Maximum growth is obtained using fast cooling combined with slow heating. Minimum growth results from the reverse of these conditions. Intermediate growth rates are obtained with slow heating and slow cooling. (W.L.H.)

**17161** TID-5061(Del.)(p.235-53)
Battelle Memorial Inst., Columbus, Ohio.
DEFORMATION OF URANIUM DURING THERMAL CYCLING. G. T. Muehlenkamp, A. D. Schwope, and L. R. Jackson. p.235-53 [of] PROCEEDINGS OF THE METALLURGY AND MATERIALS INFORMATION MEETING, APRIL 16-18, 1951, HELD AT OAK RIDGE, TENNESSEE, SPONSORED BY OAK RIDGE NATIONAL LABORATORY. VOLUME I (deleted). 19p. (BMI-82).

The thermal-expansion or deformation curves, parallel to the rod axis, of U rolled at various temperatures and given various anneals are presented. The effect of variations in the cycling temperatures in the range of 27 to 525°C on the deformation curve of 300°C-rolled, $\alpha$-annealed U have been determined, and the results analyzed in terms of the mechanism of the deformation. These results are explained on the basis of the crystal structure and anisotropy of the thermal-expansion coefficients. It is proposed that there are intercrystalline stresses step up during heating which result in plastic deformation manifested by slip and grain-boundary relaxation. The duplex texture of $\alpha$-rolled U is such that this deformation results in a lengthening in the rolling direction. (auth)

**17162** TID-5061(Del.)(p.254-63)
Argonne National Lab., Lemont, Ill.
THE DIMENSIONAL STABILITY OF SOME BINARY URANIUM ALLOYS UNDER THERMAL CYCLING. S. T. Zegler. p.254-63 [of] PROCEEDINGS OF THE METALLURGY AND MATERIALS INFORMATION MEETING, APRIL 16-18, 1951, HELD AT OAK RIDGE, TENNESSEE, SPONSORED BY OAK RIDGE NATIONAL LABORATORY. VOLUME I (deleted). 10p. (ANL-FF-10k).

Alloying U with small amounts of a suitable element to refine grain size on $\beta$-treating has appeared for some time as a possible means of obtaining optimum dimensional stability on thermal cycling. The stability of several arbitrarily selected alloys was investigated to explore this possibility. Binary alloys with Zr, Mo, Ti, V, Si, and Al were selected. Preparation involved rolling from castings to ½-in.-diam. rounds at 600°C, the first four alloy series to 89% R.A. and the Si and Al alloys to 75% R.A. Specimens, 0.364 in. in diam. by approximately 1.5 in. long, as machined and centerless ground, were used in cycling. Cycling was done between 100 and 500°C with a 5- to 7-min heating time and a 20 to 25 min cooling time in the induction heating unit at ANL. (auth)

**17163** TID-5061(Del.)(p.265-75)
Knolls Atomic Power Lab., Schenectady, N. Y.
THERMAL CYCLING OF ZINC BICRYSTALS. A. M. Turkalo. p.265-75 [of] PROCEEDINGS OF THE METALLURGY AND MATERIALS INFORMATION MEETING, APRIL 16-18, 1951, HELD AT OAK RIDGE, TENNESSEE, SPONSORED BY OAK RIDGE NATIONAL LABORATORY. VOLUME I (deleted). 11p.

Thermal cycling of a zinc bicrystal between 100 and 300°C causes a displacement of a scribed line at the grain boundary. This displacement increases with the number of cycles. This displacement along with crystalline slip which is mostly confined to one grain can cause that grain to deform continuously with respect to the other grain in a ratchet-like manner. Thermal cycling between 25 and −180°C causes general recrystalline deformation but no grain-boundary displacement. It therefore seems necessary for growth to occur that the upper temperature limit of the cycling range be at least that temperature at which grain boundary flow can occur. It appears probable that this type of dimensional instability is common to other anisotropic metals. (W.L.H.)

**17164** TID-5061(Del.)(p.277-91)
Knolls Atomic Power Lab., Schenectady, N. Y.
A MECHANISM TO ACCOUNT FOR THE DIMENSIONAL INSTABILITY OF URANIUM ON THERMAL CYCLING AND UPON PILE IRRADIATION. J. E. Burke. p.277-91 [of] PROCEEDINGS OF THE METALLURGY AND

MATERIALS INFORMATION MEETING, APRIL 16-18, 1951, HELD AT OAK RIDGE, TENNESSEE, SPONSORED BY OAK RIDGE NATIONAL LABORATORY. VOLUME I (deleted). 15p.

A theory to account for the dimensional instability of zinc bicrystals is used to explain the dimensional changes that occur in U upon thermal cycling. In a somewhat modified form, the same theory is used to explain the dimensional changes that result from pile irradiation of U. (W.L.H.)

**17165** TID-5061(Del.)(p.292-309)
Oak Ridge National Lab., Tenn.
MECHANICAL PROPERTIES OF THORIUM. D. E. Hamby. p.292-309 [of] PROCEEDINGS OF THE METALLURGY AND MATERIALS INFORMATION MEETING, APRIL 16-18, 1951, HELD AT OAK RIDGE, TENNESSEE, SPONSORED BY OAK RIDGE NATIONAL LABORATORY. Volume I (deleted). 17p.

Due to the interest in Th as a potential source of $U^{233}$ by breeding, a Th research program was undertaken at ORNL. The initial phase of the program was concerned with the mechanical properties of Th. The modulus of elasticity, shear modulus, and Poisson's ratio were determined by tensile tests using SR-4 strain gages. Other properties such as tensile strength, yield point, elongation, reduction in area, and impact strength were determined by conventional testing methods. These properties were determined using standard-size specimens of known purity. (W.L.H.)

**17166** TID-5061(Del.)(p.310-19)
Ames Lab., Ames, Iowa.
THE THORIUM–ZIRCONIUM ALLOY SYSTEM. H. A. Wilhelm and O. N. Carlson. p.310-19 [of] PROCEEDINGS OF THE METALLURGY AND MATERIALS INFORMATION MEETING, APRIL 16-18, 1951, HELD AT OAK RIDGE, TENNESSEE, SPONSORED BY OAK RIDGE NATIONAL LABORATORY. VOLUME I (deleted). 10p.

An investigation of the Th-Zr alloy system was undertaken as part of an alloy development program in which these two metals are of prime importance. The binary system has been examined in considerable detail and an equilibrium diagram proposed on the basis of these studies. The results of thermal analyses have been plotted showing the results of both the solidus determinations and solid transformation studies. Hardness data curves are of interest since they suggest the possibility of heat-treatable alloys in some regions of the system. (auth)

**17167** TID-5061(Del.)(p.321-32)
Knolls Atomic Power Lab., Schenectady, N. Y.
THE ELASTIC CONSTANTS OF SOME POSSIBLE REACTOR STRUCTURAL MATERIALS. M. B. Reynolds. p.321-32 [of] PROCEEDINGS OF THE METALLURGY AND MATERIALS INFORMATION MEETING, APRIL 16-18, 1951, HELD AT OAK RIDGE, TENNESSEE, SPONSORED BY OAK RIDGE NATIONAL LABORATORY. VOLUME I (deleted). 12p.

The ultrasonic-pulse technique offers a convenient means of measuring the elastic constants of solid materials. The measurements are nondestructive and the method has the additional advantage that a single small sample of material suffices for the determination of both the Young's modulus and the shear modulus. Tabulated results for Be, Cb, Th, Ti, U, V, Zr, stainless steel 347, and brass are given. (auth)

**17168** TID-5061(Del.)(p.335-43)
Battelle Memorial Inst., Columbus, Ohio.
THE ROLLING OF URANIUM. H. A. Saller, J. R. Keeler, and R. J. Donley. p.335-43 [of] PROCEEDINGS OF THE METALLURGY AND MATERIALS INFORMATION MEETING, APRIL 16-18, 1951, HELD AT OAK RIDGE, TENNESSEE, SPONSORED BY OAK RIDGE NATIONAL LABORATORY. VOLUME I (deleted). 9p. (BMI-86).

U has been fabricated by rolling since early in the history of the Manhattan Project, and a large amount of practical information has been accumulated. However, when new rolling facilities were being considered specifically for U, it was found that there were very few numerical data on which a design could be based. An investigation was therefore started to obtain data on the roll-separating forces while rolling U and the effect of various rolling conditions on those forces. Rolling temperatures in the range 300 to 800°C were investigated at rolling speeds of 60 to 120 fpm. Both round and flat strips were rolled. With the latter, the effect of the amount of reduction, the thickness of the rolled strip, and the initial structure were studied. (auth)

**17169** TID-5061(Del.)(p.344-62)
Los Alamos Scientific Lab., N. Mex.
URANIUM FABRICATION DEVELOPMENTS. J. M. Taub, D. T. Doll, D. E. Deutsch, L. S. Levinson, G. E. Jaynes, W. C. Gribble, R. E. Anderson, and G. S. Hanks. p.344-62 [of] PROCEEDINGS OF THE METALLURGY AND MATERIALS INFORMATION MEETING, APRIL 16–18, 1951, HELD AT OAK RIDGE, TENNESSEE, SPONSORED BY OAK RIDGE NATIONAL LABORATORY. VOLUME I (deleted). 19p. (CMR-6-659).

The recent developments at Los Alamos concerning the fabrication of U are reviewed, excerpts being taken from the LA reports numbered 1150, 1178, 1180, and 1202. The review includes forging, rolling, deep-drawing, and impact extrusion. (W.L.H.)

**17170** TID-5061(Del.)(p.381-8)
Oak Ridge National Lab., Tenn.
FABRICATION OF THORIUM. D. E. Hamby. p.381-8 [of] PROCEEDINGS OF THE METALLURGY AND MATERIALS INFORMATION MEETING, APRIL 16–18, 1951, HELD AT OAK RIDGE, TENNESSEE, SPONSORED BY OAK RIDGE NATIONAL LABORATORY. VOLUME I (deleted). 8p.

Alloys of Th have been prepared and fabricated into various test specimens. This work has given rise to some special problems because of property changes due to alloying. Very small amounts of Al, Be, and Si form hard brittle intermetallic compounds with Th and make alloys which are difficult to work. On the other hand, Zr, Ti, and Nb all soften Th and make workable alloys. These alloys may be worked in the same manner as pure Th. Extrusion of 2% Be alloys has been performed at a temperature of 950°C but requires higher pressures than for pure Th. Mn and Cr alloys are also workable and have much higher strength than pure Ames Th. (W.L.H.)

**17171** TID-5061(Del.)(p.389-98)
Westinghouse Electric Corp. Atomic Power Div., Pittsburgh.
PRODUCTION ARC MELTING OF CRYSTAL BAR ZIRCONIUM. W. J. Hurford. p.389-98 [of] PROCEEDINGS OF THE METALLURGY AND MATERIALS INFORMATION MEETING, APRIL 16-18, 1951, HELD AT OAK RIDGE, TENNESSEE, SPONSORED BY OAK RIDGE NATIONAL LABORATORY. VOLUME I (deleted). 10p. (WAPD-TD-37(Del.)).

The design of a single-electrode arc furnace to produce arc-melted crystal-bar Zr is discussed. A schematic diagram of the furnace is given. (W.L.H.)

**17172** TID-5061(Del.)(p.399-408)
Battelle Memorial Inst., Columbus, Ohio.
WELDING ZIRCONIUM. D. C. Martin and C. B. Voldrich. p.399-408 [of] PROCEEDINGS OF THE METALLURGY AND MATERIALS INFORMATION MEETING, APRIL 16-18, 1951, HELD AT OAK RIDGE, TENNESSEE, SPONSORED BY OAK RIDGE NATIONAL LABORATORY. VOLUME I (deleted). 10p. (BMI-88).

Zirconium is easily welded by the tungsten-arc method. To produce good welds which are corrosion resistant in either 300°C water or 250°C uranyl sulfate, adequate shielding must be used, and the weldment should be pickled before being put in service. Weldments in Bureau of Mines Zr have high joint efficiencies and good ductility. It is believed that the same is true for crystal-bar welds. (auth)

**17173** TID-5061(Del.)(p.409-15)
Battelle Memorial Inst., Columbus, Ohio.
THE PREPARATION AND PROPERTIES OF ZIRCONIUM-TIN ALLOYS. H. A. Saller, H. A. Pray, A. D. Schwope, L. W. Eastwood, and D. C. Martin. p.409-15 [of] PROCEEDINGS OF THE METALLURGY AND MATERIALS INFORMATION MEETING, APRIL 16-18, 1951, HELD AT OAK RIDGE, TENNESSEE, SPONSORED BY OAK RIDGE NATIONAL LABORATORY. VOLUME I (deleted). 7p. (BMI-84).

Zirconium-Sn alloys can be produced from sponge Zr and induction melted in graphite. Fabrication of the alloys is easier than that of pure Zr. The physical properties of the alloy are tabulated. (W.L.H.)

**17174** TID-5061(Del.)(p.419-37)
Westinghouse Electric Corp. Atomic Power Div., Pittsburgh.
DILATOMETRIC INVESTIGATION OF ZIRCONIUM, ZIRCONIUM-URANIUM, ZIRCONIUM-OXYGEN, AND ZIRCONIUM-NITROGEN, ALLOYS. R. K. McGeary. p.419-37 [of] PROCEEDINGS OF THE METALLURGY AND MATERIALS INFORMATION MEETING, APRIL 16-18, 1951, HELD AT OAK RIDGE, TENNESSEE, SPONSORED BY OAK RIDGE NATIONAL LABORATORY. VOLUME I (deleted). 19p. (WAPD-TD-34).

A sensitive quartz-tube differential dilatometer is described in which measurements of transformation and phase-change dilatation have been made up to 1000°C. Differences in the volume changes and temperature range of the phase transformation of as-deposited Grade 1 and Grade 3 WAPD crystal-bar Zr were found to be minor, but arc-melting of these materials produced marked changes in the shapes of the dilatation curves. A dilatometric effect was caused by the iron impurity in Zr, and a low temperature (circa 300 to 400°C) transformation was observed after arc-melting of Grade 3 crystal bar and alloys made from it. Zr-O alloys up to 1.1% oxygen and Zr-N alloys up to 0.24% nitrogen were prepared; the raising and broadening of the transformation range of temperatures caused by these elements were studied. Zr-U arc-melted and powder-metallurgy alloys were investigated dilatometrically, and the solid phase transformation data are presented as a phase diagram. The maximum solid solubility of U in Zr is estimated as about 0.8 wt. %. (auth)

**17175** TID-5061(Del.)(p.438-49)
Massachusetts Inst. of Tech., Cambridge.
ZIRCONIUM-OXYGEN AND ZIRCONIUM-HYDROGEN ALLOYS. J. Fitzpatrick and H. P. Roth. p.438-49 [of] PROCEEDINGS OF THE METALLURGY AND MATERIALS INFORMATION MEETING, APRIL 16-18, 1951, HELD AT OAK RIDGE, TENNESSEE, SPONSORED BY OAK RIDGE NATIONAL LABORATORY. VOLUME I (deleted). 12p.

Oxygen in amounts up to 0.3 wt. % raises markedly the yield and ultimate strengths of Zr at room temperature. Increasing the testing temperature however, tends to minimize the strengthening effect and at 315°C the effect is very small. The presence of hydrogen, in the form of hydrides, has a strengthening effect at room temperature. Hydrogen has a very limited solid solubility in Zr. Hydrides apparently begin forming at grain boundaries and then take up preferred positions along crystallographic planes. (W.L.H.)

**17176** TID-5061(Del.)(p.450-9)
Ames Lab., Ames, Iowa.
THE ZIRCONIUM-TIN ALLOY SYSTEM. H. A. Wilhelm and O. N. Carlson. p.450-9 [of] PROCEEDINGS OF THE METALLURGY AND MATERIALS INFORMATION MEETING, APRIL 16-18, 1951, HELD AT OAK RIDGE, TENNESSEE, SPONSORED BY OAK RIDGE NATIONAL LABORATORY. VOLUME I (deleted). 10p.

The investigation of the Sn-Zr alloy system was begun in the early part of 1950 as part of a general research program on Zr and its alloys. Alloys containing low percentages of tin exhibited considerable resistance to etching during metallographic studies which suggested a possible resistance toward corrosion. Alloys were then prepared for special corrosion testing and when favorable results from these tests were obtained the investigation was accelerated. Similar observations on tin alloys of Zr were reported by other laboratories, further confirming these findings. As a vital part of the Sn-Zr development program the phase diagram has been examined extensively and the results are reported. (auth)

**17177** TID-5061(Del.)(p.461-70)
Ames Lab., Ames, Iowa.
PRELIMINARY RESULTS ON THE ZIRCONIUM-NIOBIUM SYSTEM. E. S. Hodge. p.461-70 [of] PROCEEDINGS OF THE METALLURGY AND MATERIALS INFORMATION MEETING APRIL 16-18, 1951, HELD AT OAK RIDGE, TENNESSEE, SPONSORED BY OAK RIDGE NATIONAL LABORATORY. VOLUME I (deleted). 10p.

The results of an investigation into the general character of the Zr-Nb diagram and the resistance to corrosion of the Zr-rich alloys are presented. (W.L.H.)

**17178** TID-5061(Del.)(p.471-86)
Battelle Memorial Inst., Columbus, Ohio.
THE STRENGTH CHARACTERISTICS OF ZIRCONIUM AND SOME OF ITS ALLOYS. S. J. Stockett, L. L. Marsh, and G. T. Muehlenkamp. p.471-86 [of] PROCEEDINGS OF THE METALLURGY AND MATERIALS INFORMATION MEETING APRIL 16-18, 1951, HELD AT OAK RIDGE, TENNESSEE, SPONSORED BY OAK RIDGE NATIONAL LABORATORY. VOLUME I (deleted). 16p. (BMI-81).

The yield strength of unalloyed Foote Zr was found to be 20,000 to 26,000 psi at room temperature, 10,000 to 12,000 psi at 500°F, and 8,000 psi at 900°F. Over the temperature range from 75 to 500°F, Westinghouse Zr has practically the same tensile properties as Foote No. 1. Zr. The Zr-4% U alloy is considerably stronger than the unalloyed Zr. Its yield strength at any given temperature is about 10,000 psi above the yield strength of the base metal. The elongation values for the alloy show it to be a relatively ductile material, although not quite so ductile as the unalloyed Zr. The n values indicate that the alloy has a higher amount of usable ductility at 900°F than the unalloyed Zr or the Zr-4.82% Sn alloy. Sn is shown to increase the strength of Zr

appreciably. An addition of 4.82% Sn increased the yield strength from 21,500 psi to 50,000 psi at room temperature and from 10,600 psi to 30,000 psi at 500°F. The ultimate strength was increased from 43,800 to 59,000 psi at room temperature and from 22,100 to 37,300 psi at 500°F. The capture cross section is increased very little by the addition of Sn, which makes this alloy very promising where neutron efficiency is important. (auth)

**17179** TID-5061(Del.)(p.487-95)
INTERMETALLIC COMPOUNDS OF ZIRCONIUM AND BERYLLIUM. J. A. McGurty, S. G. Gordon, G. E. Klein, and K. M. Wizeman. p.487-95 [of] PROCEEDINGS OF THE METALLURGY AND MATERIALS INFORMATION MEETING APRIL 16-18, 1951, HELD AT OAK RIDGE, TENNESSEE, SPONSORED BY OAK RIDGE NATIONAL LABORATORY. VOLUME I (deleted). 9p. (DC-51-9-6).

Phase diagrams are presented for Be–Zr alloys. Massive bodies of these compounds have been fabricated by powder-metallurgy techniques. This has made possible a preliminary investigation of physical properties and an estimation of the usefulness of the material. (W.L.H.)

**17180** TID-5061(Del.)(p.497-507)
International Nickel Co., Inc., New York.
PROPERTIES OF A NICKEL–ZIRCONIUM ALLOY AT ELEVATED TEMPERATURES. E. N. Skinner. p.497-507 [of] PROCEEDINGS OF THE METALLURGY AND MATERIALS INFORMATION MEETING, APRIL 16-18, 1951, HELD AT OAK RIDGE, TENNESSEE, SPONSORED BY OAK RIDGE NATIONAL LABORATORY. VOLUME I (deleted). 11p.

From data obtained in an extensive test program, it is evident that a small amount of Zr added to otherwise commercially pure Ni provides one solution to the problem of raising the creep and rupture strengths of the base metal without detectable sacrifice in thermal conductivity or corrosion resistance in molten Na. Specifically, a content of 0.27% Zr in a commercial heat, tested in the annealed condition, results in a nearly three-fold improvement in strength at 510°C. While the corrosion behavior has been determined for only one medium, the alloy would be expected to be suitably resistant to any environment compatible with pure Ni. The working and fabricating characteristics present no serious difficulties, although special welding techniques will probably be required to secure consistently leak-tight joints. (auth)

**17181** TID-5061(Del.)(p.509)
Massachusetts Inst. of Tech., Cambridge.
SOME PROPERTIES OF DILUTE ALLOYS OF BERYLLIUM. C. E. Latham-Brown, A. R. Kaufmann, and P. Corzine. p.509 [of] PROCEEDINGS OF THE METALLURGY AND MATERIALS INFORMATION MEETING, APRIL 16-18, 1951, HELD AT OAK RIDGE, TENNESSEE, SPONSORED BY OAK RIDGE NATIONAL LABORATORY. VOLUME I (deleted). 1p.

Large-scale castings of Be, containing Fe, Si, Ti, Al, Zr, Ni, and U were made in an attempt to achieve a fine grain size in Be billets. After extrusion, the bar stock was to be used to study the dilute alloys in stress-rupture tests at elevated temperatures. The program, to date, is incomplete and results of the work completed are too erratic for evaluation. (auth)

**17182** TID-5061(Del.)(p.513-14)
Massachusetts Inst. of Tech., Cambridge.
DUCTILITY OF EXTRUDED BERYLLIUM POWDER. P. Loewenstein, G. Tuer, C. E. Brown, and A. R. Kaufmann. p.513-14 [of] PROCEEDINGS OF THE METALLURGY AND MATERIALS INFORMATION MEETING, APRIL 16-18, 1951, HELD AT OAK RIDGE, TENNESSEE, SPONSORED BY OAK RIDGE NATIONAL LABORATORY. VOLUME I (deleted). 2p.

In an effort to better understand the "pseudo-ductility" of extruded Be powder, a number of investigations have been carried out. Oxyten analysis of a number of bars having widely different ductility revealed no correlation. Electrical resistivity measurements, to study the effect of the bond layer, showed no significant difference between ductile and brittle material. Likewise, density determinations indicate that all the extruded metal, whether brittle or ductile, has essentially theoretical density. Variation of particle size, before extrusion, from 100 microns to 10 microns did not cause a significant variation in the ductility that was obtained. Ductility suddenly appeared when the extrusion temperature was raised above 1900°F but later experiments failed to confirm this. There is no evidence of a critical amount of reduction of area required to ensure high ductility. It was found that hot compacted metal sometimes produced high ductility rods and at other times did not. It must be concluded that as far as is known at present, careful control of extrusion variables will not guarantee ductility. (auth)

**17183** TID-5061(Del.)(p.515-25)
Brush Beryllium Co., Cleveland.
PRODUCTION OF BERYLLIUM CARBIDE AND BERYLLIUM CARBIDE–BERYLLIUM CERAMALS. Wallace W. Beaver. p.515-25 [of] PROCEEDINGS OF THE METALLURGY AND MATERIALS INFORMATION MEETING, APRIL 16-18, 1951, HELD AT OAK RIDGE, TENNESSEE, SPONSORED BY OAK RIDGE NATIONAL LABORATORY. VOLUME I (deleted). 11p.

The methods used in the production of beryllium carbide and beryllium carbide-beryllium ceramals are given. The properties of Be metal at elevated temperatures are also briefly reviewed. (W.L.H.)

**17184** TID-5061(Del.)(p.527-37)
Knolls Atomic Power Lab., Schenectady, N. Y.
A POWDER METALLURGY TECHNIQUE FOR COMBINING INSOLUBLE MATERIALS AS APPLIED TO Al–$UO_2$ FUEL ELEMENTS. Harold H. Hirsch. p.527-37 [of] PROCEEDINGS OF THE METALLURGY AND MATERIALS INFORMATION MEETING, APRIL 16–18, 1951, HELD AT OAK RIDGE, TENNESSEE, SPONSORED BY OAK RIDGE NATIONAL LABORATORY. VOLUME I (deleted). 11p.

Conditions are described for preparing Al–$UO_2$ nuclear fuel rods from the powder constituents by hot-pressing in a graphite die followed by extrusion roughly to size and finishing with a high-precision swaging operation. Some properties of the material are included and other applications of the technique are noted. (auth)

**17185** TID-5061(Del.)(p.553-60)
Lewis Flight Propulsion Lab., Cleveland.
THE SINTERING MECHANISM BETWEEN ZIRCONIUM CARBIDE AND COLUMBIUM. W. G. Lidman and H. J. Hamjian. p.553-60 [of] PROCEEDINGS OF THE METALLURGY AND MATERIALS INFORMATION MEETING, APRIL 16-18, 1951, HELD AT OAK RIDGE, TENNESSEE, SPONSORED BY OAK RIDGE NATIONAL LABORATORY. VOLUME I (deleted). 8p.

During the sintering of Zr carbide-Nb ceramal, the reaction that properly takes place is one in which the Nb displaces some of the Zr and forms Nb carbide, which is completely soluble in the Zr carbide lattice, and a homogeneous solid solution of the carbides is

formed. The displaced Zr metal tends to form in the grain corners of the carbide structures and it was found that the best strength properties were obtained with a fine dispersion of the metallic phase in the carbide matrix. The size and distribution of this phase can be controlled by two sintering variables: temperature and time of temperature. (W.L.H.)

**17186** TID-5061(Del.)(p.561-9)
Lewis Flight Propulsion Lab., Cleveland.
A STUDY OF MOLYBDENUM DISILICIDE FOR ELEVATED TEMPERATURE APPLICATIONS. W. A. Maxwell. p.561-9 [of] PROCEEDINGS OF THE METALLURGY AND MATERIALS INFORMATION MEETING, APRIL 16-18, 1951, HELD AT OAK RIDGE, TENNESSEE, SPONSORED BY OAK RIDGE NATIONAL LABORATORY. VOLUME I (deleted). 9p.

Three forms of $MoSi_2$ have been studied—a fine-grained material in the cold pressed and sintered form, and a large-grain material prepared by a modification of the hot-press method. A separate investigation has been made of fine-grain material hot pressed by a commercial supplier by more or less standard production methods. A brief description of the methods of preparation are given. The nuclear and metallurgical properties of $MoSi_2$ are reviewed. (auth)

**17187** TID-5061(Del.)(p.571-9)
Lewis Flight Propulsion Lab., Cleveland.
ELEVATED TEMPERATURE PROPERTIES OF TITANIUM CARBIDE WITH FIVE METALLIC ADDITIONS. G. C. Deutsch. p.571-9 [of] PROCEEDINGS OF THE METALLURGY AND MATERIALS INFORMATION MEETING, APRIL 16-18, 1951, HELD AT OAK RIDGE, TENNESSEE, SPONSORED BY OAK RIDGE NATIONAL LABORATORY. VOLUME I (deleted). 9p.

Titanium carbide was combined successively with Co, W, Mo, Ni, and Fe and physical properties of the resulting materials evaluated. The methods of preparation and fabrication are briefly reviewed. Shaping of the materials can be accomplished by: (1) machining in a partially sintered state while the material is somewhat chalky and machines readily; (2) grinding after final sintering, requiring in most cases the use of diamond abrasives although some success has been reported using silicon carbide; (3) extrusion, lending itself most readily to the production of such items as tubing. (W.L.H.)

**17188** TID-5061(Del.)(p.584-98)
The International Nickel Co., Inc., New York.
CORROSION TESTING. F. L. LaQue. [Paper presented at] Conference [on] CORROSION OF ZIRCONIUM IN AQUEOUS MEDIA. p.584-98 [of] PROCEEDINGS OF THE METALLURGY AND MATERIALS INFORMATION MEETING, APRIL 16-18, 1951, HELD AT OAK RIDGE, TENNESSEE, SPONSORED BY OAK RIDGE NATIONAL LABORATORY. VOLUME I (deleted). 16p.

The factors to take into consideration when corrosion testing a material are presented. (W.L.H.)

**17189** TID-5061(Del.)(p.599-602)
Massachusetts Inst. of Tech., Cambridge.
THE PRODUCTION OF CORROSION RESISTANT BUREAU OF MINES ZIRCONIUM. T. T. Magel. [Paper presented at] Conference [on] CORROSION OF ZIRCONIUM IN AQUEOUS MEDIA. p.599-602 [of] PROCEEDINGS OF THE METALLURGY AND MATERIALS INFORMATION MEETING, APRIL 16-18, 1951, HELD AT OAK RIDGE, TENNESSEE, SPONSORED BY OAK RIDGE NATIONAL LABORATORY. VOLUME I (deleted). 4p.

The method used by the Bureau of Mines for the production of zirconium is presented. It was found that by using materials of very low Al content the corrosion rate of Zr was materially reduced. (W.L.H.)

**17190** TID-5061(Del.)(p.603-5)
Battelle Memorial Inst., Columbus, Ohio.
EFFECT OF TEMPERATURE ON CORROSION RESISTANCE OF ZIRCONIUM IN WATER. H. A. Pray. [Paper presented at] Conference [on] CORROSION OF ZIRCONIUM IN AQUEOUS MEDIA. p.603-5 [of] PROCEEDINGS OF THE METALLURGY AND MATERIALS INFORMATION MEETING, APRIL 16-18, 1951, HELD AT OAK RIDGE, TENNESSEE, SPONSORED BY OAK RIDGE NATIONAL LABORATORY. VOLUME I (deleted). 3p.

The effect of temperature on the corrosion resistance of Zr in 600°F water is presented. (W.L.H.)

**17191** TID-5061(Del.)(p.606-11)
Westinghouse Electric Corp. Atomic Power Div., Pittsburgh.
THE EFFECT OF TIME AND TEMPERATURE UPON THE CORROSION OF ZIRCONIUM. D. J. DePaul. [Paper presented at] Conference [on] CORROSION OF ZIRCONIUM IN AQUEOUS MEDIA. p.606-11 [of] PROCEEDINGS OF THE METALLURGY AND MATERIALS INFORMATION MEETING, APRIL 16-18, 1951, HELD AT OAK RIDGE, TENNESSEE, SPONSORED BY OAK RIDGE NATIONAL LABORATORY. VOLUME I (deleted). 6p.

The effect of time and temperature on the corrosion of Zr is presented. (W.L.H.)

**17192** TID-5061(Del.)(p.612-15)
Argonne National Lab., Lemont, Ill.
ANODIZING AS A CORROSION TEST FOR ZIRCONIUM. R. D. Misch. [Paper presented at] Conference [on] CORROSION OF ZIRCONIUM IN AQUEOUS MEDIA. p.612-15 [of] PROCEEDINGS OF THE METALLURGY AND MATERIALS INFORMATION MEETING, APRIL 16-18, 1951, HELD AT OAK RIDGE, TENNESSEE, SPONSORED BY OAK RIDGE NATIONAL LABORATORY. VOLUME I (deleted). 4p.

By means of anodizing, it is possible to produce oxide films on Zr, and this procedure has been used for examining the pattern and mechanism of film development. (W.L.H.)

**17193** TID-5061(Del.)(p.616-17)
Ames Lab., Ames, Iowa.
CORROSION STUDIES OF ZIRCONIUM AND SOME OF ITS ALLOYS. B. A. Rodgers. [Paper presented at] Conference [on] CORROSION OF ZIRCONIUM IN AQUEOUS MEDIA. p.616-17 [of] PROCEEDINGS OF THE METALLURGY AND MATERIALS INFORMATION MEETING, APRIL 16-18, 1951, HELD AT OAK RIDGE TENNESSEE, SPONSORED BY OAK RIDGE NATIONAL LABORATORY. VOLUME I (deleted). 2p.

Corrosion studies are presented on Zr and Zr containing various amounts of Sn and Nb. (W.L.H.)

**17194** TID-5061(Del.)(p.617-21)
Battelle Memorial Inst., Columbus, Ohio.
EFFECT OF OTHER ELEMENTS ON THE CORROSION RESISTANCE OF ZIRCONIUM IN WATER. R. S. Peoples. [Paper presented at] Conference [on] CORROSION OF ZIRCONIUM IN AQUEOUS MEDIA. p.617-21 [of] PROCEEDINGS OF THE METALLURGY AND MATERIALS INFORMATION MEETING, APRIL 16-18, 1951, HELD AT OAK RIDGE, TENNESSEE, SPONSORED BY OAK RIDGE NATIONAL LABORATORY. VOLUME I (deleted). 5p.

The effect of Sn on the corrosion resistance of Zr in water is presented. (W.L.H.)

**17195** TID-5061(Del.)(p.621-63)
Westinghouse Electric Corp. Atomic Power Div., Pittsburgh.
CORROSION OF ZIRCONIUM AS AFFECTED BY VARIOUS CONTAMINANTS AND ADDITIONS. D. E. Thomas. [Paper presented at] Conference [on] CORROSION OF ZIRCONIUM IN AQUEOUS MEDIA. p.621-63 of PROCEEDINGS OF THE METALLURGY AND MATERIALS INFORMATION MEETING, APRIL 16-18, 1951, HELD AT OAK RIDGE, TENNESSEE, SPONSORED BY OAK RIDGE NATIONAL LABORATORY. VOLUME I (deleted).

A number of alloys of Zr were made by powder metallurgy techniques and corrosion tested. (W.L.H.)

**17196** WADC-TR-52-251(Pt.5)
Battelle Memorial Inst., Columbus, Ohio.
THE COMPRESSIVE CREEP BUCKLING OF METAL COLUMNS. PART 5. CYCLIC LOADING. Period Covered: January 1, 1956 to January 31, 1957. A. Rudnick, R. L. Carlson, and G. K. Manning. Mar. 15, 1957. 68p. Project title: MATERIALS ANALYSIS AND EVALUATION. Task title: DESIGN DATA FOR METALS. Contract AF33(616)-3317. (AD-155604).

The effect of load cycling on the creep buckling behavior of metal columns was determined. Two materials were investigated: 2024-T4 aluminum alloy columns with length to radius of gyration ratios of 81.2 and 55.7 at 350 and 450°F; C-110M titanium alloy columns having a length to radius of gyration ratio of 90 at 700 and 800°F. The cycling period used was 24 hr, and the time the load was on in that period was the variable. In addition to the cyclic load tests, constant load tests were conducted to obtain background information. A linear relationship was found between the time to creep buckling under constant load and the reciprocal of the minimum creep deflection rate. This relationship was used in interpreting the cyclic load test results. The effect of load cycling proved to be dependent upon the properties of the material at the testing temperature. Two criteria, based upon material stability characteristics, are set up to help classify the cyclic load data. (auth)

**17197** WADC-TR-58-29
Massachusetts Inst. of Tech., Cambridge. High Temperature Materials Lab.
A PRELIMINARY STUDY OF THE SYSTEM TITANIUM-ALUMINUM OXIDE EXTRUDED ALLOYS. Pierre Turillon and Nicholas J. Grant. Mar. 1958. 15p. Project title: SOLID STATE RESEARCH AND PROPERTIES OF MATTER. Task title: INTERACTIONS, IMPERFECTIONS AND ALLOY THEORY. Contract AF33(616)-284. (AD-155559).

A series of titanium-base alloys, containing three and ten vol. % of alumina, were studied. An additional alloy, containing 3% of rare earth oxides, was included. These alloys were prepared by powder metallurgy methods that included mechanical mixing, sintering, and extrusion. They were evaluated by a variety of tests. In several of the samples, the sintering step was omitted after cold compacting, but the density of the extrusion was the same as that obtained when using sintering. Reduction of the alumina and rare earth oxides by titanium took place in each of the extrusions, resulting in an alloy which was hard and brittle. Evidence of the reduction of the oxide by titanium was noted by means of x-ray analysis as well as by chemistry. (auth)

**17198** WADC-TR-58-63
California. Univ., Berkeley. Inst. of Engineering Research.
THE ROLE OF SUBGRAINS IN HIGH TEMPERATURE CREEP. Period Covered: January 31, 1957 to January 31, 1958. Lawrence A. Shepard and John E. Dorn. Mar. 11, 1958. 38p. Project title: MATERIALS ANALYSIS AND EVALUATION TECHNIQUES. Task title: DESIGN DATA FOR METALS. Contract AF33(616)-3860. (AD-155565).

The role of the subgrain structure in the high-temperature creep process is evaluated in the light of recent experimental and theoretical developments in creep theory. The origin of subgrains is discussed, as well as the specific deformation modes which produce the variety of observable substructures. The effect of creep variables on the subgrain development, size, and structure is described. Finally, an attempt is made to analyze the manner in which the subgrain structure affects creep rate, recovery, and grain-boundary shearing. It is concluded that the contribution of the substructure to high-temperature creep resistance is small relative to other factors. 72 references. (auth)

**17199** WAPD-CTA(MEE)-421
Westinghouse Electric Corp. Bettis Plant, Pittsburgh.
PRELIMINARY EVALUATION OF THE CRACKING TENDENCIES OF HARDENED TYPE 410 STAINLESS STEEL. M. A. Golik. Feb. 26, 1958. 4p. Includes Attachment: MINUTES OF MEETING—CORROSION STUDIES ON HARDENED AISI 410 STEEL. I. H. Welinsky. Jan. 14, 1958. 5p. Contract NObs-67500. $1.80(ph OTS); $1.80(mf OTS).

The current activities on the investigation of stress corrosion characteristics of hardened type 410 stainless steel are reviewed. (auth)

**17200** WAPD-FE-838
WAPD-FE-839
Westinghouse Electric Corp. Atomic Power Div., Pittsburgh.
DEVELOPMENT OF FUEL ROD END CLOSURES. Report No. 7 as of May 23, 1955. A. H. Kasberg. May 27, 1955. Changed from OFFICIAL USE ONLY Jan. 9, 1958. 3p. NON-DESTRUCTIVE TESTING OF END CLOSURES AND TUBING. J. G. Christ. May 27, 1955. Changed from OFFICIAL USE ONLY Apr. 23, 1958. $1.80(ph OTS); $1.80(mf OTS).

The development of fuel rod end closure welding methods is presented. (W.L.H.)

**17201** WAPD-ZH-10
Westinghouse Electric Corp. Bettis Plant, Pittsburgh.
ZIRCONIUM HIGHLIGHTS. Aug. 1958. 15p. Contract AT-11-1-GEN-14. $3.30(ph OTS); $2.40(mf OTS).

The effect of hot-worked thickness on the corrosion behavior of atmosphere-melted Zircaloy-2 is discussed. Hydrogen pickup upon etching Zircaloy-2, Zircaloy-3, and properties of vacuum-cast Zircaloy-2 and the fabrication of special Zircaloy shapes are presented. A hardness conversion chart for annealed zirconium and zirconium alloys is included. (J.E.D.)

**17202** AEC-tr-3368
THE EFFECTS OF SMALL QUANTITIES OF IMPURITIES ON THE HIGH-TEMPERATURE HARDNESS OF METALLIC TUNGSTEN. T. Millner and L. Sass. Translated from Acta Tech. Acad. Sci. Hung. 19, 115-25(1957). 7p.

The useful properties of the tungsten wires used in the incandescent lamp and radio tubes industry are ensured by adding about 1% of various ingredients (e.g., K, Na, Al, Si compounds) to the tungstic acid and producing metal powder and compressed rods. During the sintering of these rods, the additions are evaporated to such an extent that finally the concentration of foreign atoms remains only $10^{-6}$. According to the investigations, the warm hardness values of these tungsten

pieces is determined by the traces of impurities. In order to investigate the influence of the various kinds of atoms, an apparatus was built for the determination of half-micro warm hardnesses of various kinds of tungsten metals in the temperature interval 20 to 800°C. The tungsten wires made with additions containing Si had an average hardness $H_V = 250$ at 800°C, while the wires without such additions had corresponding values of $H_V = 180$. Traces of Si considerably prevent the hardness loss at 800°C of the tungsten wires which have been investigated. (auth)

**17203** AEC-tr-3378
A NEW THEORY OF ROLLING. A. Geleji. Translated for Los Alamos Scientific Lab. from Acta Tech. Acad. Sci. Hung. 19, 199-241(1957). 35p.

The theory of rolling is considered, which explains the causes of enlargement and forward slip and points out which forces are to be considered in the determination of resistance to deformation and the occurrence of some forces thus far ignored. The theory holds for both hot and cold rolling, and with the aid of the formulas deduced the resistance to forming can be calculated for any point of the compressed arc in following both a material of invariable yield strength and a material which hardens during rolling. (J.R.D.)

**17204** AEC-tr-3381
CONTRIBUTION TO EVALUATION OF THE WELDING DEFECTS BASED ON X-RAY PHOTOGRAPHS AND STRESS AND STRAIN EXPERIMENTS ON WELDED SAMPLES. Hermann Möller and Max Hempel. Translated by Lydia Venters (Argonne National Lab.) from Arch. Eisenhüttenw. 28, 531-41(1957). 24p.

The behavior of welded samples of boiler plate material with a thickness of 30 to 100 mm under stress at various load rates was investigated. Metal properties and weld seam defects, detected by x-ray analysis, were correlated, and it is pointed out that the relationship depends on the kind of defect. Welding defects were evaluated. (J.R.D.)

**17205** AEC-tr-3388
MODEL SINTERING EXPERIMENTS IN A LIQUID MEDIUM. F. Eisenkolb and I. Kaining. Translated for Oak Ridge Gaseous Diffusion Plant from Planseeber. Pulvermet. 5, 2-19(1957). 32p.

Model sintering experiments under the influence of certain secondary factors were performed. It was shown that no general determination of the autodiffusion coefficient of metals is possible with the Kuczynski model. Model experiments performed in the presence of defined secondary factors led to the conclusion that an activating effect on the sintering process can be obtained by a suitable chemical reaction with the sample material. Experiments with amalgamated copper samples showed that an effect on the sintering process by the decomposition temperature and conditioned by the thickness of solid solution layer occurs. The activated surface of a coarse particle compact show a large number of lattice defects. Therefore an increased material transport is possible at lower temperatures. In contrast, it appears that in the case of model experiments with metal melts which do not alloy with the solid component, the changed interfacial tension in the melt is not sufficiently large to counteract the strength of the sample material in spite of the decreased shrinkage occurring at higher temperatures and to accelerate the material transport. (auth)

**17206** AEC-tr-3390
THEORY OF THE LOW TEMPERATURE PEAK OF THE INTERNAL FRICTION OF METALS. (Zur Theorie des Tieftemperaturmaximums der Inneren Reibung von Metallen). Hans Donth. Translated for Oak Ridge National Lab. from Z. Physik 149, 111-30(1957). 33p.

The low-temperature peaks of internal friction of metals, interpreted as kinks (over-dislocations), were investigated. Pairs of kinks can develop continuously through an increase in energy from normal vibrations of the dislocation line, and the energy enrichment is not a spontaneous but a stochastic process which can be described as the diffusion of energy-forming points of vibrations. The average velocity and the diffusion coefficient of the movement of these energy-forming points are calculated, and the relaxation time for the formation of kink pairs with a sufficient distance for the release of the dislocation transfer is determined. (J.R.D.)

**17207** AERE-Lib/Trans-798
THE INVESTIGATION AND CHOICE OF ALLOYS FOR HIGH-TEMPERATURE THERMOCOUPLES. A. A. Rudnitskii and I. I. Tyurin. Translated by M. de O. Tollemache (U.K.A.E.A. Atomic Energy Research Establishment) from Zhur. Neorg. Khim. 1, 1074-90 (1956). 23p.

Alloys for use in thermocouples at 1350 to 1550°C were investigated. The most stable thermoelectrodes at 1350°C are pure rhodium and the alloy 80% Pt -20% Rn, and at 1550°C the thermoelectric characteristics were less stable. This alloy can also be used at 1800°C for short periods if corundite capillary insulation is used. (J.R.D.)

**17208** NP-tr-153
ON THE MECHANISM OF THE ANODIC DISSOLUTION OF MAGNESIUM. B. N. Kabanov and D. V. Kokoulina. Translated by Morris D. Friedman (Lincoln Lab., MIT) from Doklady Akad. Nauk S.S.S.R. 120, 558-61(1958). 7p.

The mechanism of the rapid stage in the presence of a slower one for the process of anodic oxidation of a metal has not been explained successfully because of the experimental and theoretical difficulties. This appears to be possible at the present time in the case of metals which form a monovalent ion, unstable in solution, as the transition state during anodic dissolution. The process of magnesium dissolution in acid solutions is given. The oxidation of metallic magnesium up to the monovalent stage is the slowest of the electrochemical stages of this process since two parallel stages proceed after it, of which the diffusion into the solution is almost always rapid because of the instability of the monovalent ions. The electrochemical oxidation of metallic magnesium is retarded very intensely when it adsorbs oxygen, i.e., it is passivated. (auth)

**17209**
URANIUM OCCURRENCE IN BADEN-WÜRTTEMBERG. Franz Kirchheimer. Atombrief 4, 210-11(1958). (In German)

The report deals in detail with the cobalt, bismuth, and silver ores in Kinzigtal, the deposits near Lahr, and the seams of iron and manganese ores in both the central and southern regions of the Black Forest. It is suggested that the mining of uranium ores near Wittichen and Lahr might be economically feasible. (auth)

**17210**
PULSE-ANNEALING TECHNIQUE FOR METALS AND ALLOYS. P. Wright and K. Thomas (University Coll. of North Wales, Bangor, Caerns, Eng.). Brit. J. Appl. Phys. 9, 330-3(1958) Aug.

An account is given of some improvements in the technique of pulse annealing. Procedures for sharpening up the

pulsing and quenching processes and for accurately controlling the annealing temperature are described. Some experimental results on $Cu_3Au$ are given to illustrate the special uses of the pulse-annealing method. (auth)

**17211**

FRICTIONAL BEHAVIOUR AND STRUCTURE OF THE SURFACE OXIDES OF STEEL. Yasukatsu Tamai (Univ. of Tokyo). Brit. J. Appl. Phys. 9, 338-9(1958) Aug.

An investigation was made of the frictional behavior of high-carbon steel treated in various ways. The coefficient of friction was measured with a pendulum-type apparatus in which the steel specimens were arranged in the form of "cross cylinders." The frictional sliding was therefore reciprocating, and the condition seemed more severe and more likely to cause breakdown of the surface oxide film than in unidirectional sliding. Measurements were made at loads of 100g and 25g per contact and at the maximum speed of about 3mm/sec. The period of swing was about 2 c/s. Results are shown graphically. (auth)

**17212**

SET-UP FOR GROWING SINGLE CRYSTALS OF METALS. Bohdan Sestak (Phyics Inst., Czechoslovak Academy of Sciences). Ceskoslov. Casop. Fys. 7, No. 2, 202-8(1957) and Ceskoslov. Fiz. Zhur. 7, No. 2, 234-41 (1957). (Translated from Referat. Zhur. Fiz. No. 1, 1958, Abstract No. 1040)

The construction of an apparatus is proposed for growing large single crystals of metals (particularly ferromagnetic metals) from a melt and by the recrystallization method. The fundamental portion of the apparatus is a vertical electric furnace with a molybdenum helix, placed on a tube made of sintered aluminum oxide, which makes it possible to obtain temperatures up to 1600°C. The thermal insulation of the furnace is effected by three concentric shielding cylinders. The single crystals were grown in an atmosphere of argon at atmospheric pressure. The mechanism for moving the crucible is mounted in the upper portion of the furnace and provides the possibility of both manual and automatic displacement with a velocity range from 5 to 95 mm per hour. The protective atmospheres are purified of oxygen and dried in a special apparatus during crystal growth. The procedure of growing single crystals of copper and nickel by the Bridgeman method is described. Copper crystals of diameter 12 mm and purity 99.95% were grown in a graphite crucible at velocities of 37.2 to 76 mm per hour, and nickel crystals 99.85% pure and 15 mm in diameter were grown in a crucible made of pure sintered aluminum at a crucible displacement rates of 9.1 to 25 mm per hour.

**17213**

ALUMINUM ALLOYS. Ralph L. Horst, Jr. (Aluminum Co. of America). Ind. Eng. Chem. 50, 1427-32(1958) Sept.

A series of new aluminum–magnesium alloys has been developed. Applications of these alloys in the aircraft, building, chemical, nuclear, and transportation industries are discussed. (D.E.B.)

**17214**

LESS COMMON METALS. E. M. Sherwood (Battelle Memorial Inst., Columbus, Ohio). Ind. Eng. Chem. 50, 1455-9(1958) Sept.

The intensified research and development devoted to the less common metals has disclosed a number of heretofore relatively unknown properties useful in new equipment for the nuclear era. A review of the properties and uses of Zr, Hf, Mo, Nb, Ta, Cr, and Re is presented. (J.R.D.)

**17215**

NICKEL, INCLUDING HIGH-NICKEL ALLOYS. Albert J. Marron (International Nickel Co.). Ind. Eng. Chem. 50, 1460-9(1958) Sept.

A review of information obtained from abstracts prepared by the International Nickel Co. is presented. The review is divided into four sections, including research, development, and physical metallurgy, applications of nickel and high-nickel alloys, high-temperature application, and welding and fabrication of nickel and high-nickel alloys. (J.R.D.)

**17216**

STAINLESS STEELS AND OTHER FERROUS ALLOYS. W. A. Luce and J. H. Peacock (Duriron Co.). Ind. Eng. Chem. 50, 1482-8(1958) Sept.

The metallurgy and recent developments in stainless steels are presented, including advancements in welding and improvements in mechanical properties through additions of misch metal. With service requirements becoming more demanding, radically new developments are expected in the next few years, with considerable attention centering on stress corrosion, high-temperature properties, and various applications. (J.R.D.)

**17217**

TIN AND ITS ALLOYS. Robert M. MacIntosh (Tin Research Inst.). Ind. Eng. Chem. 50, 1489-92(1958) Sept.

A review of the metallurgy and applications of tin is presented, including uses of tin-based solders, electrodeposited protective coatings, hot tinning of iron surfaces, bronze production methods, and uses in other alloys, especially Zircaloy-2. (J.R.D.)

**17218**

TITANIUM. Howard B. Bomberger (Rem-Cru Titanium, Midland, Penna.). Ind. Eng. Chem. 50, 1493-5(1958) Sept.

Titanium production and uses were developed largely in the last decade. A reduction in consumer requirements occurred in 1957; however, the growth potential in this industry is considered to be high. A review of developments in production, fabrication, applications, and corrosion properties of titanium is presented. (J.R.D.)

**17219**

THE TERNARY SYSTEMS $BaO-TiO_2-SnO_2$ AND $BaO-TiO_2-ZrO_2$. G. H. Jonker and W. Kwestroo (Philips Research Labs., Eindhoven, Netherlands). J. Am. Ceram. Soc. 41, 390-4(1958) Oct.

An investigation of the ternary systems $BaO-TiO_2-SnO_2$ and $BaO-TiO_2-ZrO_2$ led to the discovery of two new compounds belonging to the system $BaO-TiO_2$. These compounds, $Ba_2Ti_5O_{12}$ and $Ba_2Ti_9O_{20}$, are stabilized by minute additions of $SnO_2$ or $ZrO_2$. The known compound $BaTi_2O_5$ can be obtained only from the molten phase and decomposes below 1300°C into $Ba_2Ti_5O_{12}$ and $BaTiO_3$. In these systems no ternary compounds are found. The ternary phase diagrams can be divided into regions with high and low dielectric losses, which are in accordance with the phase relations. Tables with crystallographic data of the new compounds are included. (auth)

**17220**

EFFECT OF OXIDE ADDITIONS ON SINTERING OF MAGNESIA. James W. Nelson and Ivan B. Cutler (Univ. of Utah, Salt Lake City). J. Am. Ceram. Soc. 41, 406-9 (1958) Oct.

The effect of transition metal, alkali, alkaline-earth, and heavy metal oxide additions on the sintering of magnesia was determined by measuring bulk density and shrinkage. Polished specimens were made on selected

compositions and the grain structure was photographed. The unusual effect of titanium, zirconium, silicon, lithium, iron, and zinc oxides in promoting high sintered densities is explained on the basis of the defective crystal structure produced by these additions. (auth)

**17221**

DIFFUSION OF INDIUM IN TIN SINGLE CRYSTALS. Anton Sawatzky (Franklin Inst. Labs. for Research and Development, Philadelphia). J. Appl. Phys. 29, 1303-5 (1958) Sept.

The rate of diffusion of indium in single crystals for two orientations has been measured using the radioactive isotope $In^{114}$. The diffusion coefficients in the directions parallel to the a axis and c axis are given by the Arrhenius relations $D_a = 34.1 \exp(-25\,800/RT)$ cm$^2$ sec$^{-1}$ and $D_c = 12.2 \exp(-25\,600/RT)$ cm$^2$ sec$^{-1}$, respectively. The anisotropy is discussed in terms of the vacancy mechanism of diffusion. (auth)

**17222**

TRANSPORT AND CHEMICAL CONTROL IN THE DISSOLUTION OF METALS IN MERCURY. J. A. R. Bennet and J. B. Lewis (Atomic Energy Research Establishment, Harwell, Berks, Eng.). J. chim. phys. 55, 83-90(1958) Feb. (In French)

The rate of dissolution of cylinders of lead, tin, and zinc in mercury were studied and the results were compared with the dissolution of benzoic acid in water since it is known as being a process of controlled diffusion. While the dissolution of lead and tin is also a process of controlled diffusion, the dissolution of zinc is in a part a chemical process. In order to have conditions of reproducible agitation, the cylindrical samples, attached coaxially, were mounted in a revolving cylinder containing the mercury. Some experiments with cylindrical single crystals of zinc have shown that the different crystal faces have different speeds of dissolution. Qualitatively, the same phenomena were found for bismuth and cadmium. (tr-auth)

**17223**

PREPARATION AND PROPERTIES OF ALUMINUM ANTIMONIDE. A. Herczog, R. R. Haberecht, and A. E. Middleton (P. R. Mallory & Co. Inc., Indianapolis). J. Electrochem. Soc. 105, 533-40(1958) Sept.

Aluminum and antimony of high purity were prepared by zone refining, and single crystals of AlSb were grown by the Czochralski technique. Effects of various impurities in the starting materials and crucibles on the electrical properties are discussed, and equipment for crystal growing under equilibrium vapor pressure of Sb is described. The resistivity of as-grown-P-type crystals can be decreased substantially by doping with carbon and increased by small quantities of Se and Te. A larger quantity of Te will change the crystals to N-type. P-N junctions were made by controlled doping during crystal growing. Effects of various surface treatments on the electrical properties of AlSb are discussed, and some data on point contact and P-N junction diodes are presented. (auth)

**17224**

AN EVALUATION OF INTERFACE ENERGIES IN METALLIC SYSTEMS. J. W. Taylor. J. Inst. Metals 86, 456-63(1958) June.

A method is presented for calculating solid/solid and solid/liquid interface energies based on estimates of grain-boundary energies of a number of pure metals and solid solutions. These grain-boundary energies are derived from the corresponding liquid surface energies, coupled with the following assumptions: (i) The surface energy of a solid metal or alloy may be estimated from that of the corresponding liquid by applying a correction of one-third of the latter for the increase of surface energy on freezing. (ii) The grain-boundary energy of a metal or alloy is taken as being one-third of the corresponding solid surface energy. In solid/solid boundaries it is suggested that the interfacial energy between different phases is lower than the grain-boundary energy of either of the individual phases; that this interfacial energy approximates to, but is generally a little lower than, the grain-boundary energy of lower value in a two-phase system; and that crystallographic factors appear to have a minor effect in determining the interfacial energy with boundaries having a large degree of misfit. Effects of alloying additions on grain-boundary and interface energies are also discussed. In solid/liquid boundaries the interfacial energy is closely related to the solubility of the solid metal in the liquid for the initial few per cent of solubility; thereafter the dependence is not marked. Evidence is presented to show that the interfacial energy changes with solubility according to the Gibbs adsorption equation; the formation of an adsorbed monolayer has the greatest effect on the liquid/solid interfacial energy. (auth)

**17225**

A REVIEW PAPER ON THE CONSTITUTION OF URANIUM-MOLYBDENUM ALLOYS. A. J. Carrea (National Commission of Atomic Energy, Buenos Aires) and D. R. F. West and J. G. Ball (Imperial Coll., London). J. Nuclear Energy 7, 189-98(1958) Sept.

Reports of investigations of the constitution of uranium-molybdenum alloys are summarized and differences between the proposed equilibrium diagrams are discussed. It is apparent that the differences are due partly to the difficulty of establishing equilibrium in the solid state transformations. A compiled equilibrium diagram is shown. (auth

**17226**

ACTIVITIES IN THE CHROMIUM-NICKEL SYSTEM. M. B. Panish, R. F. Newton, W. R. Grimes, and F. F. Blankenship (Oak Ridge National Lab., Tenn.). J. Phys. Chem. 62, 980-2(1958) Aug.

Chromium activities in the nickel-chromium system were obtained from the potentials between chromium and alloy electrodes in an electrolyte of molten NaCl-RbCl mixture containing about 0.5% $CrCl_2$. Seven alloy compositions ranging from 11 to 96 atomic % chromium were studied at 750°, and the 53 and 96% alloys also at 965°. The activity coefficient of chromium at 750° ranges from about 0.5 to 1.0 as the chromium concentration increases to 30%, then increases sharply as the miscibility limit at 40% is approached. (auth)

**17227**

POWDER METALLURGY OF REFRACTORY METALS. Alan Blainey (Anglo-American Corp., Johannesburg). Metal Progr. 74, No. 3, 95-6, 184, 186, 188, 190(1958) Sept.

Nb, V, Zr, and Be are discussed as cladding metals for nuclear fuel elements. The considerations include the applications of Zr in water cooled and moderated reactors, the use of Nb in thermal or fast reactors, V in fast reactors, and Be as fuel element cladding material for moderately high-temperature thermal reactors. The primary emphasis in the discussion is powder metallurgy, alloys, and compacting and sintering techniques. Also included is a discussion of experimental work on a magnesium-containing dispersed oxide of low density and good high-temperature strength. (J.R.D.)

**17228**
BRAZING ALLOYS FOR GUIDED MISSILES. A. T. Cape. Metal Progr. 74, No. 3, 99–104(1958) Sept.

A discussion is presented of brazing materials for use at relatively low temperatures (including copper and silver alloys), alloys for use up to 1600°F, and recently developed alloys used in conjunction with unusual requirements such as brazing extraordinarily wide gaps, brazing difficult to join materials, and others. (J.R.D.)

**17229**
WELDING THE REFRACTORY METALS. L. F. Yntema (Stanford Research Inst., Menlo Park, Calif.). Metal Progr. 74, No. 3, 105–8(1958) Sept.

Welding methods for use with Ta, Nb, Mo, and W are described, including resistance welding, submerged arc welding, and inert-gas–shielded-arc welding. These welding techniques were evolved because of the reactivity of the metals in air and their affinity to low-melting metals. (J.R.D.)

**17230**
PRESENT AND FUTURE USES OF TITANIUM. Paul M. Tyler (National Academy of Sciences, Washington). Metal Progr. 74, No. 3, 109–12, 170, 172, 174, 176, 178, 180, 182(1958) Sept.

The cost and present uses of titanium are discussed, and the future progress in production is analyzed. The price of titanium has been steadily reduced and at present is $2.05/lb. in 100-lb. lots. A newly developed electrolytic process gives promise of reducing the production cost to $0.80/lb. Included in the discussion is an analysis of competition with steel in aircraft, Army and Navy uses, and the future of production. (J.R.D.)

**17231**
STRUCTURE AND MECHANICAL PROPERTIES OF WELDED SEAMS OF ALLOYED TITANIUM. S. M. Gurevich (Platon Inst. of Electric Weldings, Academy of Sciences, Ukrainian SSR). Metalloved. i Obrabotka Metal. No. 8, 18–21(1958) Aug. (In Russian)

Effects of $\alpha$ and $\beta$ alloying admixtures of Al, Cu, Cr, Fe, Mn, Mo, Sn, and V (up to 7%) on the microstructure and mechanical properties of welded joints of titanium were studied. (R.V.J.)

**17232**
THE AGING FRIABILITY OF 20XH14C2 STEEL AT 500 TO 650°. A. V. Tikhomirov, N. V. Sukhobokova, and N. A. Tikhomirova. Metalloved. i Obrabotka Metal. No. 8, 22–5(1958) Aug. (In Russian)

The stability and aging friability of austenitic stainless steel 20XH14C2 (21% Cr, 13.24% Ni, 2.83% Si, and 1.14% Mn, with small admixtures of C, S, and P), used as construction material for special power plant equipment, were investigated. (R.V.J.)

**17233**
EFFECTS OF SUPERHEATED WATER VAPOR ON THE AUSTENITE STEEL RESISTANCE. E. A. Davidovskaya and L. P. Kestel (Central Research Inst. of Machine Building and Metalworking). Metalloved. i Obrabotka Metal. No. 8, 29–33(1958) Aug. (In Russian)

It is shown that pure superheated vapor does not affect the stabilized resistance of austenite at 600°C; however, the presence of various salts may affect the durability of steel, especially at high tension. (R.V.J.)

**17234**
EFFECTS OF NICKEL ADMIXTURES ON THE PHASE TRANSFORMATIONS IN Al–Cu ALLOYS AT PROLONGED HIGH TEMPERATURE ANNEALING. A. Z. Zhmudskii and P. A. Maksimyuk (Kiev State Univ.). Metalloved. i Obrabotka Metal. No. 8, 34–7(1958) Aug. (in Russian)

The admixture of nickel retards the diffusion processes in Al – Cu – Ni alloys at elevated temperature and increases the heat resistance of aluminum alloys. (R.V.J.)

**17235**
STIRRING IN STEEL PRODUCTION. MECHANICAL AND INDUCTIVE STIRRING IN THE ARC FURNACE. Arne Faerden. Metallurgia 58, 57–63(1958) Aug.

A survey of developments in the production of electric steels is presented, including methods of stirring, such as mechanical, inductive, reladling, furnace rotation, and the method by which gases or metallic vapors are forced through the melt. The results obtained during mechanical stirring are given, and the relative merits of the mechanical and inductive methods are discussed. (auth)

**17236**
METALLURGY IN NUCLEAR ENGINEERING. SURVEY OF THE LITERATURE IN 1957. J. Burkett (Hawker Siddeley Nuclear Power Co., Ltd.). Metallurgia 58, 64–6(1958) Aug.

The literature dealing with metallurgical aspects of thorium, uranium, and uranium dioxide was surveyed, including production of the metals and physical, chemical, and mechanical properties. In addition, various thorium and uranium alloys are discussed, along with a survey of reactor welding techniques and materials. (J.R.D.)

**17237**
NEW MAGNESIUM ALLOYS. R. J. M. Payne and N. Bailey (J. Stone & Co. (Charlton), Ltd.). Metallurgia 58, 67–8(1958) Aug.

A series of magnesium alloys was developed recently, known as M.S.R. alloys. They contain silver, rare earth metals, and zirconium. A discussion of preparation, properties, and uses is presented. (J.R.D.)

**17238**
THE PACK CARBURISING AND ANNEALING OF 4% Ni–Cr–Mo CASE HARDENING STEEL. C. Dawes (Joseph Lucas, Ltd., Birmingham). Metallurgia 58, 69–75(1958) Aug.

A standard method of annealing is discussed, emphasizing a necessary compromise in selecting the subcritical temperature to soften both the case and the core, since if the most suitable temperature below the lower critical is used for the core, transformation is slow in the case. Techniques recommended for use in eutectoid and hypereutectoid cases are described. (J.R.D.)

**17239**
CONTINUOUS GALVANIZING OF STEEL STRIP. ARMCO SENDZIMIR LINE INSTALLED AT EBBW VALE. Metallurgia 58, 76–9(1958) Aug.

The older cleaning techniques for steel were replaced by carefully controlled oxidation and reduction with simultaneous annealing which produces a surface allowing instantaneous bonding between the steel base and the zinc. The absence of the conventional flux allows addition to the smelter of such elements as aluminum which minimizes brittleness and improves workability. In addition the zinc coat has uniform thickness ensuring good corrosion behavior. A description of the process and equipment is given. (J.R.D.)

**17240**
HEAT TREATMENT AND CLEANING IN WIRE PRODUCTION, WITH PARTICULAR REFERENCE TO DARWINS' NEW PLANT. Ernest Hague (Electric

Resistance Furnace Co., Ltd.). Metallurgia 58, 80-3 (1958) Aug.

The usual treatment of steel wire in production to realize certain desired qualities is discussed, and two specialized treatments (spheroidizing and patenting) are described. Following the general production discussions, the Kingfield works plant is described, including the annealing furnaces and the wire cleaning equipment. (J.R.D.)

**17241**

THE PREPARATION OF TIN AND TIN ALLOYS FOR MICRO EXAMINATION. B. L. Eyre. Metallurgia 58, 95-106(1958) Aug.

New methods and techniques for preparing tin and tin alloys for microexamination were developed, based on the use of successively finer grades of diamond compound for all except the final stage of polishing. Photomicrographs are included which illustrate various aspects of the techniques of polishing and etching. (J.R.D.)

**17242**

HYSTERESIS CYCLE OF SINGLE CRYSTALS FROM Al-Fe ALLOYS. Hermann Gengnagel (Inst. für Magnetische Werkstoffe, Jena, Germany). Naturwissenschaften 45, 361(1958). (In German)

Single crystals of Al-Fe alloys containing 3 and 4% Al were prepared. The magnetic anisotropic constant was found to be $K_1$ $4 \times 10^5$ erg/cm$^3$. After annealing at 1000° and slow cooling in the furnace, the hysteresis cycle was measured. No rectangular cycle was found in the 4% alloy, but it was found in the 3% alloy. Possible reasons for this behavior are discussed. (J.S.R.)

**17243**

ON THE MECHANISM OF OXIDE FILM FORMATION ON ZIRCONIUM. O. Flint and J. H. O. Varley (Atomic Energy Research Establishment, Harwell, Berks., Eng.). Phys. and Chem. Solids 6, 213-22(1958) Aug.

Some experiments are described that indicate the extent to which the initial surface condition of zirconium controls both thermal and anodic oxidation of the metal. Some observations of the effect of ultraviolet light are also reported. The interpretation suggested for these observations is in terms of the possible variation in electronic work function and defect state of the oxide depending upon the physical condition of the metal surface. These variations will affect the efficiency of anodic film formation, and a qualitative scheme of possible mechanisms whereby film growth is controlled is described. (auth)

**17244**

THE MAGNETIC SUSCEPTIBILITY OF METALS. F. J. Blatt (Michigan State Univ., East Lansing). Phys. and Chem. Solids 6, 301-3(1958) Aug.

Factors affecting the magnetic susceptibility of metals, and particularly of alkali and noble metals, are discussed. Data are tabulated on the susceptibilities of lithium and sodium. (C.H.)

**17245**

NOTE ON THE MAGNETIC SUSCEPTIBILITY OF DILUTE Cu-Mn ALLOYS. A. J. Dekker (Univ. of Minnesota, Minneapolis). Physica 24, 697-706(1958) Aug.

On the basis of a simple model, the following features of the susceptibility of dilute copper-manganese alloys are discussed: (a) the concentration dependence of the effective Curie temperature in the high temperature region; (b) the occurrence of a "gradual" antiferromagnetic transition at low temperatures; (c) the concentration dependence of the position and shape of the antiferromagnetic transition. (auth)

**17246**

OBSERVATIONS REGARDING PROPERTIES AND PERFORMANCE OF CONTINUOUSLY CAST LOW-CARBON STEEL PRODUCTS. M. Tenenbaum, R. N. Edmondson, and Logan Mair (Inland Steel Co., East Chicago, Ind.). Trans. Met. Soc. AIME 212, 431-45(1958) Aug.

The processing of cast sections of low-carbon steel, properties of various final-rolled products, and the performance of those products in commercial application are discussed. (J.E.D.)

**17247**

THE ANTIMONY-ZIRCONIUM SYSTEM IN THE RANGE 0 TO 5 At. % ANTIMONY. J. O. Betterton, Jr. and W. M. Spicer (Oak Ridge National Lab., Tenn.). Trans. Met. Soc. AIME 212, 456-7(1958) Aug.

The solubilities of antimony in the $\alpha$ and $\beta$ forms of zirconium were determined between 750 and 1300°C. The $\alpha$ phase forms by a peritectoid reaction, and the $\alpha/(\alpha + \beta)$ and $\beta/(\alpha + \beta)$ phase boundaries rise in temperature with increasing antimony. Impurities in the 99.95% zirconium were sufficient to influence the phase boundaries and the variation reported is approximate. The restricted solid solubility of the terminal zirconium phases, which is especially characteristic of this system, is thought to result from the low free energy of the $Zr_2Sb$ phase. (auth)

**17248**

OXIDATION RESISTANCE AND FABRICABILITY OF MOLYBDENUM-NICKEL DISPERSION ALLOYS. E. S. Bartlett, D. N. Williams, and R. I. Jaffee (Battelle Memorial Inst., Columbus, Ohio). Trans. Met. Soc. AIME 212, 458-63(1958) Aug.

The oxidation resistance and fabricability of molybdenum powder-metallurgy alloys containing up to 20 wt. % nickel in the form of a fine dispersion were studied. The effects of dispersion distribution and of amount and type (pure nickel or nickel compounds) of additive were considered. A definite improvement in oxidation resistance was observed, but the amount of improvement fell far short of requirements for an oxidation-resistant alloy. Fabricability by hot-rolling was limited. (auth)

**17249**

EFFECT OF HYDROGEN ON SOME MECHANICAL PROPERTIES OF A TITANIUM ALLOY HEAT-TREATED TO HIGH STRENGTH. H. A. Robinson (Cities Service, Inc., Lake Charles, La.), P. D. Frost (Battelle Memorial Inst., Columbus, Ohio), and W. M. Parris (Titanium Metals Corp., Henderson, Nev.). Trans. Met. Soc. AIME 212, 464-9(1958) Aug.

The effects of hydrogen content and strain rate on the static tensile and notch-rupture properties of the Ti-3Mn-complex alloy heat-treated to different strength levels were investigated. The extent of embrittlement was found to be proportional to the amount of hydrogen present and the strength to which the specimens were heat-treated. The research suggests the possible necessity of specifying lower hydrogen limits than are now allowed when titanium alloys are heat-treated to higher strengths than are presently used. The research also supports a hypothesis advanced earlier for a mechanism of hydrogen embrittlement. (auth)

**17250**

THE SILVER-ZIRCONIUM SYSTEM. J. O. Betterton, Jr. and D. S. Easton (Oak Ridge National Lab., Tenn.). Trans. Met. Soc. AIME 212, 470-5(1958) Aug.

A detailed investigation was made of the phase diagram of silver-zirconium, particularly in the region

0 to 36 at. % Ag. The system was found to be characterized by two intermediate phases $Zr_2Ag$ and ZrAg and a eutectoid reaction in which the $\beta$-zirconium solid solution decomposes into $\alpha$-zirconium and $Zr_2Ag$. It was found that impurities in the range 0.05% from the iodide-type zirconium were sufficient to introduce deviations from binary behavior, and that with partial removal of these impurities an increase in the $\alpha$-phase solid solubility limit from 0.1 to 1.1 at. % Ag was observed. (auth)

**17251**

INTERNAL FRICTION AND YOUNG'S MODULUS OF HEXAGONAL AND CUBIC COBALT. M. E. Fine and E. H. Greener (Northwestern Univ., Evanston, Ill.). Trans. Met. Soc. AIME 212, 476-8(1958) Aug.

An investigation was made of the internal friction and Young's modulus of cobalt as functions of strain amplitude. Below 480°C variation of the driving voltage by a factor of 10 did not change these properties. The internal friction near 250°C begins to increase until 560°C, the highest temperature measured. Young's modulus increases approximately linearly from 25 to 400°C. The temperature coefficient of modulus over this range is $4.3 \times 10^{-4}$ per degree C. (auth)

**17252**

PROCESSING AND PROPERTIES OF COBALT–PLATINUM PERMANENT-MAGNET ALLOYS. D. L. Martin (General Electric Co., Schenectady, N. Y.). Trans. Met. Soc. AIME 212, 478-85(1958) Aug.

The study of cobalt–platinum alloys has been of interest since they represent a class of permanent-magnet material in which the disorder-to-order transformation plays a controlling role. The magnetic properties of alloys in the range 40 to 60 at. % have been found to be greatly influenced by composition and heat-treatment. The peak properties of 4700 coercive force and 9,000,000 gauss-oersteds energy product were obtained by controlled cooling and aging. These high values combined with ductility and machinability give the alloys useful characteristics although their high cost limits their application. (auth)

**17253**

TENSILE PROPERTIES OF Ti–20U AND Ti–30U ALLOYS. H. A. Robinson, O. J. Huber, and P. D. Frost (Battelle Memorial Inst., Columbus, Ohio). Trans. Met. Soc. AIME 212, 485-6(1958) Aug.

A preliminary investigation was made to determine the tensile properties attainable in two heat-treated binary titanium–uranium alloys containing 20 to 30% uranium. Both alloys responded to heat treatment, producing materials with tensile strength in the range 100,000 to 180,000 psi with adequate ductility for most structural applications. Both alloys exhibited a loss in ductility when a solution treatment at 1600°F preceded the aging treatment. (J.E.D.)

**17254**

THE ACTIVITIES OF ALUMINUM AND IRON IN IRON–ALUMINUM MELTS AT 1600°C. R. D. Pehlke (Massachusetts Inst. of Tech., Cambridge). Trans. Met. Soc. AIME 212, 486-7(1958) Aug.

The activities of Fe and Al in Al–Fe melts at 1600°C are plotted. (J.E.D.)

**17255**

THE EFFECT OF OXYGEN ON THE IMPACT TRANSITION OF IODIDE TITANIUM. E. H. Rennhack (New Jersey Zinc Co., Palmerton, Penns.). Trans. Met. Soc. AIME 212, 487-9(1958) Aug.

The presence of sufficient quantities of carbon, oxygen, and nitrogen was found to decrease the room temperature impact resistance of titanium. The transition was observed to be in evidence at a lower oxygen equivalent percentage. (auth)

**17256**

VACUUM MELTING: INFLUENCE OF HYDROGEN PRETREATMENT OF CRUCIBLES ON OXYGEN CONTENT OF IRON CHARGES. T. J. Bosworth (General Electric Research Lab., Schenectady, N. Y.). Trans. Met Soc. AIME 212, 489-93(1958) Aug.

The effect of hydrogen pretreatment of alumina, magnesia, and zirconia crucibles on reduced oxygen levels in iron charges has been studied. Hydrogen treatment of commercial high-purity magnesia crucibles was observed to produce as high as 70% reduction in oxygen content in iron melts. Hydrogen treatment of the commercial high-purity grade zirconia crucibles produced a 25% reduction in oxygen levels in iron melts. An average reduction of Knoop hardness of 47% was recorded on the iron charges melted in hydrogen-treated crucibles. On the basis of the experiments and the free-energy diagram, it appears that the major source of reducible oxygen to the iron charge is the suboxides and impurity oxides rather than the major oxide of the crucible. Suitable pretreatment of the crucibles to reduce and remove these oxides yields low oxygen levels in iron melted in the crucibles. (auth)

**17257**

FURTHER STUDIES OF THE IRON–CHROMIUM SYSTEM. R. O. Williams (Cincinnati Milling Machine Co., Ohio). Trans. Met. Soc. AIME 212, 497-502(1958) Aug.

A study utilizing neutron diffraction, electrical resistance, and chemical extraction has been carried out to clarify the chromium-rich part of the miscibility gap previously proposed for this system. This gap appears to be more symmetrical than previously supposed and is very flat. This flatness is believed to be the result of a cooperative phenomenon perhaps of magnetic origin; in particular, it is believed that the chromium-rich phase is antiferromagnetic. The presence of antiferromagnetism is believed to result in an additional strengthening mechanism very similar to that for ordered precipitates. Likewise, it is proposed that the quenched alloys which are known to be ferromagnetic have antiferromagnetic regions which accounts for the maximum in hardness around 75% Cr. It is also believed that the existence of antiferromagnetism in other alloys of transition elements might explain some of their anomalous characteristics. (auth)

**17258**

INTERGRANULAR CAVITATION IN STRESSED COPPER–NICKEL ALLOYS. B. J. Reid (Metal Manufacturers, Ltd., Port Kembla, N.S.W.) and J. N. Greenwood (Univ. of Melbourne). Trans. Met. Soc. AIME 212, 503-7(1958) Aug.

It has been shown that cavities are formed in the grain-boundaries of copper and 70:30 brass (as well as in magnesium) by the application of tensile stresses at elevated temperatures. For a given rate of strain, cavities are formed in brass at a lower temperature than in copper, and they are larger; it was thought that this earlier onset of cavitation in the alloy might be caused by the distortion produced in the metal lattice by the alloying element. If the cavitation is caused by the vacancy-migration mechanism, the distortion of the lattice would reduce the energy required for vacancy formation, and thus provide vacancies more readily to assist in the cavitation process. (auth)

**17259**

FURTHER STUDIES ON THE METALLURGY OF

SILICON IRON. SOME OBSERVATIONS ON SELECTIVE OXIDATION. A. U. Seybolt and E. I. Alessandrini (General Electric Research Lab., Schenectady, N. Y.). Trans. Met. Soc. AIME 212, 507-9(1958) Aug.

Selective oxidation (preferential oxidation of a single alloy component) can be an important oxidation mode in the case of alloys such as Si–Fe, Al–Fe, and so on, when heat-treating in atmospheres of low oxygen potential. It was the purpose of this work to identify the oxide films formed on iron containing 3¼% Si at low oxygen potentials, and to make some observations on the $H_2O/H_2$ ratios required to form them. (auth)

**17260**

HYDROGEN IN TITANIUM–ALUMINUM ALLOYS. L. W. Berger, D. N. Williams, and R. I. Jaffee (Battelle Memorial Inst., Columbus, Ohio). Trans. Met. Soc. AIME 212, 509-13(1958) Aug.

The effects of hydrogen on the properties of binary Ti–Al alloys containing 2.5, 5, and 7% aluminum and ternary alloys of the same compositions with added interstitial elements oxygen, nitrogen, and carbon were studied. Aluminum increases the apparent hydrogen solubility of the $\alpha$-phase, resulting in a marked increase in resistance to impact embrittlement. In the Ti–5Al and Ti–7Al alloys, for example, the addition of 180 and 305 ppm hydrogen, respectively, did not cause embrittlement, while unalloyed titanium was embrittled by as little as 75 ppm. The role of aluminum in increasing hydrogen solubility of the $\alpha$-phase probably accounts for the excellent hydrogen tolerance of $\alpha$-$\beta$ alloys containing considerable amounts of aluminum. There is some evidence that aluminum retards the rate of hydride precipitation. If so, these alloys may be susceptible to slow-strain embrittlement. (auth)

**17261**

THE PLASTIC FLOW OF MOLYBDENUM AT LOW TEMPERATURE. G. A. Alers (Ford Motors Research Labs.), R. W. Armstrong (University, Leeds, Eng.), and J. H. Bechtold (Westinghouse Research Labs., Pittsburgh). Trans. Met. Soc. AIME 212, 523-8(1958) Aug.

The plastic flow of molybdenum was studied in compression at temperatures below the ductile-to-brittle transition in tension. It was found that molybdenum is ductile in compression at all temperatures down to −196°C. The yield strength continues to increase with decreased test temperature below the tensile ductile-to-brittle transition temperature range. Difficulty was encountered in correlating the experimental data obtained with existing theories of plastic flow. (auth)

**17262**

HYDROGEN, CRACK INITIATION, AND DELAYED FAILURE IN STEEL. H. H. Johnson (Lehigh Univ., Bethlehem, Penna.), J. G. Morlet (French Army), and A. R. Troiano (Case Inst. of Tech., Cleveland). Trans. Met. Soc. AIME 212, 528-36(1958) Aug.

Delayed failure in steel occurs by controlled initiation and growth of a crack. The incubation period for crack initiation was measured. Crack initiation and propagation are controlled by interaction between hydrogen concentration and triaxial stress state. The incubation period results from stress-induced diffusion of hydrogen to the point of crack initiation. (auth)

**17263**

CREEP CHARACTERISTICS OF MAGNESIUM SINGLE CRYSTALS FROM 78° TO 364°K. H. Conrad (Westinghouse Research Lab., Pittsburgh) and W. D. Robertson (Yale Univ., New Haven, Conn.). Trans. Met. Soc. AIME 212, 536-43(1958) Aug.

Incremental loading creep tests were conducted on magnesium single crystals in tension and direct shear at 78 to 364°K. The creep curves were transient in character and exhibited waves or periodic behavior, especially at small strain rates. A sigmoidal curve was frequently observed following the first occurrence of creep. Repeating of segments of a master curve was observed at all temperatures indicating that identical conditions for flow existed after various stress and strain histories. A logarithmic time law with $\alpha$ independent of temperature was observed at 78 and 203°K, while a parabolic (power) time law was approximated at 298 and 364°K. The departure from logarithmic creep was attributed to recovery, which was observed at 298 and 364°K. The temperature independence of $\alpha$ represents a serious objection to the theory of low-temperature creep based on the intersection of dislocations. (auth)

**17264**

THE EFFECT OF HIGH-TEMPERATURE AGING ON THE DEVELOPMENT OF MINOR PHASES IN AN AGE-HARDENING NICKEL–BASE ALLOY. W. C. Bigelow, J. A. Amy, and L. O. Brockway (Univ. of Michigan, Ann Arbor). Trans. Met. Soc. AIME 212, 543-9(1958) Aug.

Specimens of Inconel-X alloy solution-treated at 2050°F and aged for periods of 1, 10, 100, and 1000 hr at 1200, 1400, and 1600°F have been examined by electron microscopy and by electron and x-ray diffraction. Four minor phases were identified: titanium nitride, niobium nitride, an $M_{23}C_6$ complex carbide, and the intermetallic $\gamma'$ phase. The two nitrides were found in all of the aged specimens and in the solution-treated alloy, the $\gamma'$ phase formed at all aging temperatures, while the $M_{23}C_6$ carbide formed only on aging at 1200 and 1400°F. Variations in the hardness, rupture strength, creep strength, and yield strength of the alloy have been shown to be related to variation in the size and distribution of the particles of the $\gamma'$ phase within the matrix grains of the alloy, with maximum values of these properties occurring when there is a maximum amount of the phase present and a fine state of dispersion of the particles prevails. (auth)

**17265**

ACTIVITY OF OXYGEN IN LIQUID IRON ALLOYS. T. P. Floridis (General Electric Co., Schenectady, N. Y.) and J. Chipman (Massachusetts Inst. of Tech., Cambridge). Trans. Met. Soc. AIME 212, 549-53(1958) Aug.

The equilibrium of gaseous $H_2O-H_2$ mixtures with liquid iron is used to establish the activity coefficient of dissolved oxygen as $\log f_0 = -0.20$ [%O]. Discrepancies in earlier work are explained or eliminated. Additions of cobalt, molybdenum, tungsten, and platinum increase the activity coefficient of oxygen whereas copper and gold decrease it. (auth)

**17266**

AN ACOUSTICAL STUDY OF LOW TEMPERATURE AGING IN Al–4.2% Cu. M. E. Fine and Charles Chiou (Northwestern Univ., Evanston, Ill.). Trans. Met. Soc. AIME 212, 553-7(1958) Aug.

While Gunier-Preston zones are growing in Al–4.2% Cu at room temperature, Young's modulus, measured dynamically, increases about 0.4%. From the change in modulus with time the exponent of time in the rate equation for growth of the zones was deduced to be ½. From a comparison of the rates of increase of modulus at 1, 28, and 42°C an activation energy of 12 to 14 kcal per mole is computed. These findings support the idea that copper atoms are supplied along dislocation channels to growing zones. (auth)

**17267**
THE ROLE OF RATE-HISTORY EFFECTS IN THE CALCULATION OF CREEP BEHAVIOR. J. D. Lubahn (General Electric Co., Schenectady, N. Y.). Trans. Met Soc. AIME 212, 557-63(1958) Aug.

Prior tests by Dorn, where the strain rate in a tensile test was suddenly changed, have shown a small but definite rate-history effect to exist. If this effect is neglected in the calculation of creep behavior from tensile results, an error should occur. This paper shows that this error is smaller than experimental scattering, and may be neglected. (auth)

**17268**
THE SOLID SOLUBILITY OF PHOSPHORUS IN NICKEL. J. Koeneman and A. G. Metcalfe (Illinois Inst. of Tech., Chicago). Trans. Met. Soc. AIME 212, 571-2(1958) Aug.

The nickel deposit produced by the catalytic nickel reduction process was found to be an amorphous solid. Crystallization occurred at elevated temperatures when the original powder pattern which showed only a diffuse ring with a d-spacing of 2.01 A became sharp, revealing nickel and nickel phosphide lines. The phosphide was indexed on a tetragonal lattice of parameters a = 9.01 A and c = 4.42 A, which is in reasonable agreement with the structure of $Ni_3P$ proposed by other workers. (J.E.D.)

**17269**
DIAGRAM OF STATE AND PROPERTIES OF ALLOYS OF THE SYSTEM Ni–Ti. L. I. Pryakhina. Trudy Inst. Metallurg. Akad. Nauk S.S.S.R. 2, 119-25(1957). (Translated from Referat. Zhur. Fiz. No. 1, 1958, Abstract No. 942)

The system Ni-Ti was investigated by the methods of microstructure, specific electric resistivity, and hardness. A region of limited gamma solid solution of Ti in Ni was established at 800°. The curve of solubility of Ti and Ni at 800° passes between the compounds with 8 and 10.8% Ti. Diagrams of the composition vs. the electric resistivity, the hardness, and the refractory properties have been plotted and studied for alloys of the Ni-Ti system (containing up to 16% Ti). It is shown that the maximum refractory properties at 800° is possessed by alloy compounds, corresponding to the transition region from the limiting saturation to the supersaturated solid solutions (8 and 10.8% Ti).

**17270**
INVESTIGATION OF THE SYSTEM Mn–Ce. M. S. Mirgalovkaya and I. A. Strel'mikova. Trudy Inst. Metallurg. Akad. Nauk S.S.S.R. 2, 135-8(1957). (Translated from Referat. Zhur. Fiz. No. 1, 1958, Abstract No. 943)

Using thermal analysis and microstructure investigation methods, a study was made of the Mn–Ce system. The diagram of state was plotted. The eutectic point corresponds to a temperature of 635° and a composition of ~5.0% Mn and ~950% Ce. The liquidus curve consists of four branches, corresponding to the primary crystallization of three modifications of Mn and the crystallization of the high temperature modification of Ce.

**17271**
WELDING CAST COMPONENTS FOR NUCLEAR-POWER APPLICATIONS. W. H. Rice (Electric Steel Foundry Co., Portland, Ore.). Welding J. (N. Y.) 37, 971-8(1958) Oct.

As specifications for quality control of materials become more rigid, an extensive program is necessary to assure that the base metal, weld, and fusion zones meet the required mechanical and metallurgical properties, both as-welded and after heat treatment. A discussion of materials such as austenitic and martensitic stainless steels and carbon steels is presented, along with considerations of operator proficiency, production control, and inspection. (J.R.D.)

**17272**
WELDING QUALIFICATION AND COMPONENT PERFORMANCE. W. L. Fleischmann (General Electric Co., Schenectady, N. Y.). Welding J. (N. Y.) 37 991-6 (1958) Oct.

Component performance and weldability tests are interrelated, and in the context of component performance weldability tests assume the role of simulated service tests. Joint welding procedure qualifications have been found to be made under rather closely controlled conditions and many tribulations associated with weld fabrications are due to insufficient attention to details. The conclusion has been reached that weld qualification should include workmanship standards. These workmanship standards can be an effective tool for quality control on the floor of the fabricating shop so that the nondestructive tests performed on the completed welds can be passed with great assurance. (auth)

**17273**
WELDING OF MOLYBDENUM-ALLOY SHEET. K. M. Kulju and W. H. Kearns (General Electric Co., Cincinnati, Ohio). Welding J. (N.Y.) 37, 440s-4s(1958) Oct.

The equipment and welding procedures used to obtain mechanical properties of arc-welded joints in molybdenum alloy containing ½% titanium are described. The material used was 0.062 in. thick sheet, and the welding was done in a gas-tight enclosure containing helium. (J.R.D.)

**17274**
ON THE PROBLEM OF DETERMINING THE FATIGUE LIMIT. V. S. Ivanova and L. K. Gordiyenko. Zavodskaya Lab. 23, 1489-91(1957).

A new method for determining the fatigue limit of metals is suggested. The method is based on a rapid determination of the resistivity limit. (J.S.R.)

# PHYSICS

**17275** AD-138426
Radiation Research Corp., New York.
NUCLEAR BATTERIES. Quarterly Progress Report No. 2 [for] February 15, 1957–May 15, 1957. John H. Coleman. 33p. DA Project No. 3-99-09-000. Contract DA-36-039-SC-73115.

Investigations of tritium battery components continued, including the assembly of two foils containing 50 curies in the tritium source production system. A new collector surface containing two thin layers of carbon was incorporated, and several enclosure types were designed with two different terminals. Models of tritium batteries were fabricated and tested producing 0.1 and 1.0 millimicroamperes, and a battery producing 10 microamperes was designed. (J.R.D.)

**17276** ASAE-S-10
American-Standard. Atomic Energy Div., Mountain View, Calif.
BIBLIOGRAPHY FOR NUCLEAR AND CONVENTIONAL MERCHANT SHIPS. Frederick L. May. June 30, 1958. 105p. Contract AT(04-3)-109. $2.50(OTS).

Approximately 1,000 references to technical reports on nuclear and conventional merchant ships are cited. (T.R.H.)

**17277** GAT-DM-650
Goodyear Atomic Corp., Portsmouth, Ohio.
AN APPROXIMATION USED TO INTERPRET STEREO ELECTRON MICROGRAPHS. John A. Pond. Feb. 7, 1958. 6p. $1.80(ph OTS); $1.80(mf OTS).

Within the range of operating conditions for the electron microscope, the error introduced by the Heidenreich approximation is negligible. (auth)

**17278** ISC-1075
Ames Lab., Ames, Iowa.
EFFECTS OF ELASTIC AND PLASTIC DEFORMATION ON THE PROPERTIES OF SUPERCONDUCTORS. C. A. Swenson. [Sept. 19, 1958]. 15p. Contract [W-7405-eng-82]. $3.30(ph OTS); $2.40(mf OTS).

Moderate mechanical deformation probably has little effect on $(\partial T_c/\partial P)_{H=0}$ for superconducting tin. While the transition temperatures (and critical field curves) for tantalum may vary widely from sample to sample due to gaseous or metallic impurities, the value of $(\partial T_c/\partial P)_{H=0}$ does not vary appreciably. (auth)

**17279** LAMS-2219
Los Alamos Scientific Lab., N. Mex.
ON THE POSSIBILITY OF EXTRACTING ENERGY FROM GRAVITATIONAL SYSTEMS BY NAVIGATING SPACE VEHICLES. Stanislaw Ulam. Apr. 1, 1958. 7p. Contract W-7405-eng-36. $1.80(ph OTS); $1.80(mf OTS).

A number of problems of the following type are outlined: We assume an astronomical system composed of two or more stellar bodies and a space vehicle which, as an additional body of infinitely small mass compared to the celestial objects, forms part of a many-(e.g., 3)-body system. We assume that the "rocket" not only describes the trajectory under the action of the gravitational forces, but also that it has still a reserve energy available for steering by suitably emitted impulses. This energy will be assumed to be roughly of the order of the kinetic energy which the rocket already possesses. The problem, broadly speaking, involves the possibility of using this reserve energy in such a way as to acquire, by suitable near collisions with one or the other of the celestial bodies, much more kinetic energy than it possesses—more by an order of magnitude than the available reserve energy would allow it to acquire by itself. (auth)

**17280** TID-2501(Del.)
Technical Information Service, AEC.
NUCLEAR SCIENCE AND TECHNOLOGY. (EXTRACTS FROM JOURNAL OF METALLURGY AND CERAMICS. ISSUE NOS. 1 TO 6, JULY 1948—JANUARY 1951.) Decl. with deletions May 14, 1957. 421p. $73.10(ph OTS); $11.10(mf OTS).

About thirty papers are included in this issue. Separate abstracts have been prepared for each paper. (W.L.H.)

**17281** TID-2501(Del.)(p.1-11)
Battelle Memorial Inst., Columbus, Ohio.
PREPARATION AND PROPERTIES OF THE ALUMINUM—URANIUM ALLOYS. H. A. Saller. p.1-11 [of] NUCLEAR SCIENCE AND TECHNOLOGY. (EXTRACTS FROM JOURNAL OF METALLURGY AND CERAMICS. ISSUE NOS. 1 TO 6, JULY 1948—JANUARY 1951). 11p.

The constitution diagram of aluminum—uranium is replotted on a weight per cent basis. In spite of slight age hardening no significant solid solubility of uranium in aluminum is indicated. A eutectic between aluminum and $UAl_4$ occurs at approximately 13 weight % uranium. $UAl_4$ is produced by peritectic reaction between $UAl_3$ and liquid of 18% uranium. $UAl_3$ also occurs. Melting and casting of alloys are described as well as the forging and rolling characteristics. Tensile and hardness properties of variously heat treated rolled and forged samples containing from 2.43 to 16.8% uranium are tabulated. Creep data for a 17.3% uranium alloy sample and thermal conductivity of forged bars containing 12.5, 22.7 and 30.5% uranium are also included. (auth)

**17282** TID-2501(Del.)(p.13-17)
Knolls Atomic Power Lab., Schenectady, N. Y.
FORMING URANIUM DIOXIDE WASHERS AND RODS. Robert McKechnie and Alan U. Seybolt. p.13-17 [of] NUCLEAR SCIENCE AND TECHNOLOGY. (EXTRACTS FROM JOURNAL OF METALLURGY AND CERAMICS. ISSUE NOS. 1 TO 6, JULY 1948—JANUARY 1951). 5p.

Both pressed discs and washers, and small extruded rods were made of $UO_2$. These shapes were not of very high density, varying from about 8 g/cc for the flat shapes to 7 g/cc for the extruded rods; theoretical density of $UO_2$ is about 10.3 g/cc. It was found necessary to incorporate organic "binders" to secure satisfactory forming characteristics. Sintering in a hydrogen atmosphere at about 1600°C produced reasonably strong and hard bodies, readily handled without dusting or breakage. $UO_2$ is wet by sodium at temperatures near 500°C, and low density $UO_2$ bodies tend to disintegrate into powder due to some unknown action of the sodium. However, if the $UO_2$ sintered density is near 8 g/cc or over, several days exposure to hot sodium appears to have no effect other than wetting the oxide. It appears feasible to produce pellets or washers of $UO_2$ in automatic compacting machines. (auth)

**17283** TID-2501(Del.)(p.19-47)
National Bureau of Standards, Washington, D. C.
THE BINARY ALLOYS OF URANIUM. Robert W. Buzzard and Harold E. Cleaves. p.19-47 [of] NUCLEAR SCIENCE AND TECHNOLOGY. (EXTRACTS FROM JOURNAL OF METALLURGY AND CERAMICS. ISSUE NOS. 1 TO 6, JULY 1948—JANUARY 1951). 29p.

A condensed summary of the available information on several binary alloy systems of uranium was prepared in connection with a current research project at the National Bureau of Standards. At the suggestion of Dr. Bruce Old, Chief, Metallurgy and Materials Branch, Research Division, U.S. Atomic Energy Commission, this summary has been expanded to include all binary alloys of uranium for which information is accessible to the authors. The assistance of Dr. J. C. Warner, Carnegie Institute of Technology, and Dr. H. D. Young, Argonne National Laboratories, in securing some of the information included in this summary is gratefully acknowledged. A more detailed survey of the uranium alloy systems is being compiled by Dr. Warner for inclusion in Volume 12, Division IV of the National Nuclear Energy Series. The diagrams presented herein are those proposed by the various investigators but redrawn to a uniform scale. Much of the information on which these diagrams are based is the product of investigations whose aim was specific information on alloy characteristics rather than the establishment of the alloy diagrams. Hence these diagrams are mainly tentative, subject to the revision that future data may require. The broken lines indicate approximate limits proposed by the investigation but for which substantiating data are lacking. (auth)

**17284** TID-2501(Del.)(p.59-84)
Massachusetts Inst. of Tech., Cambridge.
THE MECHANICAL PROPERTIES OF BERYLLIUM.

D. W. Lillie, P. Gordon, and A. R. Kaufmann. p.59-84 [of] NUCLEAR SCIENCE AND TECHNOLOGY. (EXTRACTS FROM JOURNAL OF METALLURGY AND CERAMICS. ISSUE NOS. 1 TO 6, JULY 1948-JANUARY 1951). 26p.

It has been recognized since the early days of nuclear energy production that beryllium should be an ideal material for pile construction; first, because it is an excellent moderator; and second, because, being a metal, it might reasonably be expected to have mechanical properties which would allow its use as a structural material. That beryllium has to date not been so employed may be attributed largely to two factors; namely, the relative ease with which very pure graphite could be obtained during the war when time was such an important consideration, and the paucity of information available concerning the metallurgical and mechanical properties of beryllium. The situation with regard to both these factors has been appreciably improved as a consequence of research and development during the past several years. The present paper is a report of information concerning the mechanical properties of beryllium resulting from research carried out at MIT under the auspices of the Manhattan Project and the Atomic Energy Commission. Beryllium metal available at the present time is produced chiefly by one or the other of two general techniques. In the first of these, $BeF_2$ is reduced with magnesium and the metal is made available in the form of lumps. The lump metal is then refined by vacuum melting and cast, also under vacuum, into billets. The billets are usually fabricated into useful shapes by extrusion, although rolling and forging techniques have also been used with some success. Lump metal can also be fabricated by powder metallurgy techniques as in the Brush "QT" process. In the second production technique the beryllium is obtained in the form of flakes by the electrolysis of beryllium chloride. The flake metal is processed by cold compression of the flakes into billet form, followed by hot extrusion of the compacted billet. The mechanical property testing to be described below has been carried out most extensively on extruded vacuum cast lump beryllium, but both extruded flake and metal fabricated by powder metallurgy methods have been investigated to some extent. (auth)

**17285** TID-2501(Del.)(p.115-26)
Massachusetts Inst. of Tech., Cambridge.
THE SOLUBILITY OF URANIUM AND THORIUM IN LIQUID METALS AND ALLOYS. E. E. Hayes and P. Gordon. p.115-26 [of] NUCLEAR SCIENCE AND TECHNOLOGY. (EXTRACTS FROM JOURNAL OF METALLURGY AND CERAMICS. ISSUE NOS. 1 TO 6, JULY 1948-JANUARY 1951). 12p.

Of the twenty-two metals or alloys tried as solvents for U, it was found that pure Bi and pure Al dissolve the largest quantities of U at the lowest temperatures. Fifteen solvents were tried for Th. In this case pure Al gave the best results. Aluminum was tried as a solvent in a ternary system involving both U and Th and was found to dissolve considerable amounts of both elements. (W.L.H.)

**17286** TID-2501(Del.)(p.127-49)
Carnegie Inst. of Tech., Pittsburgh.
THE INFLUENCE OF PILE RADIATIONS ON SOLID MATERIALS. Frederick Seitz. p.127-49 [of] NUCLEAR SCIENCE AND TECHNOLOGY. (EXTRACTS FROM JOURNAL OF METALLURGY AND CERAMICS. ISSUE NOS. 1 TO 6, JULY 1948-JANUARY 1951). 23p.

This article represents a revision and digest of reports M-4075 and M-3990, based on lectures given at the training program of Clinton Laboratories (1946-47).

The theory of the influence of bombardment by neutrons and fission fragments on the properties of solids is summarized. The results are used as a basis for reviewing the experimental observations concerning the changes induced in metals and insulators that have been exposed to pile radiations. It is pointed out that the atoms that are knocked-on by close collisions with fast neutrons and fission fragments are responsible for secondary effects which represent an important part of the influence of the primary radiations. Equations are given for estimating the fraction of the energy of one of the primary particles which is expended in excitation and ionization of the electrons in the medium through which these particles are passing and the fraction which is expended in transmitting kinetic energy to the atoms as a whole. Of the latter fraction about one half induces lattice vibrations and the remaining half produces permanent displacements of the atoms in typical materials of construction. Quantitative estimates are given of the number of atoms that are permanently displaced by fission neutrons and fission fragments in several interesting materials; graphite, beryllium, beryllium oxide, and aluminum. In addition, the changes induced in uranium metal by fission fragments are summarized in detail. It is found that the theoretical calculations are in good agreement with the experimental results that have been observed to date, particularly for graphite and beryllium oxide in which the effects do not reverse automatically at normal operating temperatures. It is suggested that the changes induced in metals such as aluminum and beryllium are reversed almost at once during exposure and that most of the effects observed in uranium metal are caused by the fission products, which behave like foreign atoms, and by the thermal agitation that accompanies the passage of fission fragments. (auth)

**17287** TID-2501(Del.)(p.163-72)
[Ames Lab.], Ames, Iowa.
PRODUCTION OF THORIUM METAL. PART I. PURIFICATION OF THORIUM NITRATE AND THE SUBSEQUENT PRODUCTION OF THORIUM OXALATE. W. D. Tucker and H. A. Wilhelm. p.163-72 [of] NUCLEAR SCIENCE AND TECHNOLOGY. (EXTRACTS FROM JOURNAL OF METALLURGY AND CERAMICS. ISSUE NOS. 1 TO 6, JULY 1948-JANUARY 1951). 10p. (ISC-33).

Commercial thorium nitrate is purified by solvent extraction and an oxalate precipitation. This is the beginning step in the production of pure thorium metal by the Iowa State College Institute for Atomic Research. A review is given of the preliminary experimental work which preceeded the present pilot-plant process. The operation and equipment of this pilot plant are described in detail. (auth)

**17288** TID-2501(Del.)(p.173-82)
[Ames Lab.], Ames, Iowa.
PRODUCTION OF THORIUM METAL. PART II. PRODUCTION OF THORIUM OXIDE AND THORIUM FLUORIDE. R. H. Giffen and H. A. Wilhelm. p.173-82 [of] NUCLEAR SCIENCE AND TECHNOLOGY. (EXTRACTS FROM JOURNAL OF METALLURGY AND CERAMICS. ISSUE NOS. 1 TO 6, JULY 1948-JANUARY 1951). 10p. (ISC-34).

Thorium oxide and thorium fluoride are produced at the Iowa State College Institute for Atomic Research as a step in the production of thorium metal. Thorium oxalate of high purity is dried and calcined to the oxide, which is subsequently hydrofluorinated at an elevated

temperature to produce anhydrous thorium fluoride. A review is given of both the experimental work leading up to the present pilot-plant process and the current developmental work for improving this process. The operation and equipment of this pilot plant are described in detail. (auth)

**17289** TID-2501(Del.)(p.183-95)
Oak Ridge National Lab., Tenn.
THERMAL CONDUCTIVITY OF URANIUM-BEARING MATERIAL UNDER IRRADIATION AT HIGH TEMPERATURES. L. P. Hunter. p.183-95 [of] NUCLEAR SCIENCE AND TECHNOLOGY. (EXTRACTS FROM JOURNAL OF METALLURGY AND CERAMICS. ISSUE NOS. 1 TO 6, JULY 1948–JANUARY 1951). 13p. (CF-48-10-135(Del.)).

Results are given on the effects of irradiating uranium-bearing refractory materials at high temperatures. The effect of the size of the fuel particles is noted, and conclusions are drawn regarding the use of such materials in fuel elements in high-temperature piles. (auth)

**17290** TID-2501(Del.)(p.211-16)
Knolls Atomic Power Lab., Schenectady, N. Y.
A TECHNIQUE FOR PRODUCING BORON–ALUMINUM COMPACTS. Harold Hirsch. p.211-16 [of] NUCLEAR SCIENCE AND TECHNOLOGY. (EXTRACTS FROM JOURNAL OF METALLURGY AND CERAMICS. ISSUE NOS. 1 TO 6, JULY 1948–JANUARY 1951). 6p. (KAPL-M-HHH-1).

Also issued separately as KAPL-M-HHH-1 and previously abstracted in NSA, Vol. 10, abstract No. 8896.

**17291** TID-2501(Del.)(p.217-36)
Massachusetts Inst. of Tech., Cambridge. Metallurgical Project.
RECRYSTALLIZATION OF COLD-ROLLED URANIUM. E. E. Hayes. p.217-36 [of] NUCLEAR SCIENCE AND TECHNOLOGY. (EXTRACTS FROM JOURNAL OF METALLURGY AND CERAMICS. ISSUE NOS. 1 TO 6, JULY 1948–JANUARY 1951). 20p. (MIT-1021(Del.)).

The first phase of this study was to determine the recrystallization range of cold-rolled, fine-grained uranium as a function of per cent reduction. With a final reduction of 25% uranium has a recrystallization range of 450 to 500°C (1½ hr annealing time). This range is lowered approximately 50°C for reductions over 90%. For lower reductions the recrystallization range is somewhat higher. Below 2% reduction complete recrystallization does not occur for an annealing time of 1½ hr. After completion of the first phase of the program, additional material was annealed in the gamma range to obtain the large gamma grain size to investigate the possibility of producing suitable, fine-grained material by subjecting coarse-grained material to moderate amounts of cold rolling followed by annealing for recrystallization. Uranium given this treatment recrystallized with a resulting fine grain size at approximately the same temperatures as above (reductions of from 2% to 25% only were made). The resulting fine grains, however, appear to form clusters of grains with orientations similar or related to the original coarse-grained material. (auth)

**17292** TID-2501(Del.)(p.237-45)
Los Alamos Scientific Lab., N. Mex.
FABRICATION OF $U^{235}$ DISCS FOR THE GENERAL ELECTRIC POWER PILE. R. E. Eldmann and J. M. Taub. p.237-45 [of] NUCLEAR SCIENCE AND TECHNOLOGY. (EXTRACTS FROM JOURNAL OF METALLURGY AND CERAMICS. ISSUE NOS. 1 TO 6, JULY 1948–JANUARY 1951). 9p. (LA-720).

The experimental critical assembly being used at the Knolls Atomic Power Laboratory of the General Electric Company utilizes thin discs of $U^{235}$ metal in its construction. The discs were fabricated at the Los Alamos Scientific Laboratory through a series of casting, rolling, and blanking operations and marked and packed for shipment. A brief description of development work which was done on the casting and rolling processes is included. (auth)

**17293** TID-2501(Del.)(p.277-90)
Massachusetts Inst. of Tech., Cambridge. Metallurgical Project.
EXTRUSION OF URANIUM AT LOW TEMPERATURES. S. V. Arnold and R. M. Treco. p.277-90 [of] NUCLEAR SCIENCE AND TECHNOLOGY. (EXTRACTS FROM JOURNAL OF METALLURGY AND CERAMICS. ISSUE NOS. 1 TO 6, JULY 1948–JANUARY 1951). 20p. (MIT-1022).

A review of recent experience in the extrusion of uranium metal at temperatures below the alpha-beta phase transformation is presented. A discussion of the effects of billet temperature and reduction ratio on the properties of metal fabricated by alpha extrusion is included. It is shown that this process is quite feasible, providing a wide variety of microstructures and attendant physical properties. (auth)

**17294** TID-2501(Del.)(p.291-316)
Knolls Atomic Power Lab., Schenectady, N. Y.
PROBLEMS IN THE USE OF MOLTEN SODIUM AS A HEAT TRANSFER FLUID. Clifford E. Weber and Leo F. Epstein. p.291-316 [of] NUCLEAR SCIENCE AND TECHNOLOGY. (EXTRACTS FROM JOURNAL OF METALLURGY AND CERAMICS. ISSUE NOS. 1 TO 6, JULY 1948–JANUARY 1951). 26p. (KAPL-139).

The basis for the current interest in liquid metals as coolants for nuclear reactors is discussed, and the favorable characteristics of liquid sodium as a heat transfer medium are pointed out. This is followed by a critical analysis of the available data on the physical properties of Na of importance in this application, i.e., density, heat capacity, viscosity, surface tension, thermal conductivity, electrical resistivity, heat transfer coefficients, and nuclear characteristics. The chemical properties of sodium are discussed, including its reactions with oxygen, water, hydrogen, nitrogen, carbon, metallic oxides, and other metals. (auth)

**17295** TID-2501(p.317-49)
Argonne National Lab., Lemont, Ill.
DIMENSIONAL CHANGES IN URANIUM UNDER THERMAL CYCLING. L. R. Kelman. p.317-49 [of] NUCLEAR SCIENCE AND TECHNOLOGY. (EXTRACTS FROM JOURNAL OF METALLURGY AND CERAMICS. ISSUE NOS. 1 TO 6, JULY 1948–JANUARY 1951). 33p. (ANL-FF-54(Del.2).

Uranium undergoes permanent dimensional changes when thermal cycled in the alpha-temperature range without passing through any phase transformations. This deformation is attributed to the anisotropy of thermal expansion inherent in noncubic metals. Alpha uranium, which is orthorhombic, is especially susceptible because of its high anisotropy of thermal expansion. Uranium rods prepared by a wide variety of fabrication and heat-treat methods were thermal cycled between 100 and 550°C. Observations were made on the effects of fabrication technique, heat treatment, and thermal cycling on the dimensions, surface roughening, microstructure, and preferred orientation of these rods. (auth)

**17296** TID-2501(Del.)(p.367-70)
Los Alamos Scientific Lab., N. Mex.
SOME CONSIDERATIONS INVOLVED IN THE DESIGN

OF A LABORATORY FOR WORK WITH ALPHA ACTIVE MATERIALS. F. M. Walters. p.367-70 [of] NUCLEAR SCIENCE AND TECHNOLOGY. (EXTRACTS FROM JOURNAL OF METALLURGY AND CERAMICS. ISSUE NOS. 1 TO 6, JULY 1948–JANUARY 1951.) 4p.

Factors requiring consideration in designing laboratories for chemical and metallurgical research on alpha-active materials are discussed, and plans for a proposed building at Los Alamos designed to meet the special requirements are presented with explanations, including the first floor plan for the building. (auth)

**17297** TID-2501(Del.)(p.371-82)
Brookhaven National Lab., Upton, N. Y.
BROOKHAVEN NATIONAL LABORATORY FUEL ELEMENTS. David H. Gurinsky. p.371-82 [of] NUCLEAR SCIENCE AND TECHNOLOGY. (EXTRACTS FROM JOURNAL OF METALLURGY AND CERAMICS. ISSUE NOS. 1 TO 6, JULY 1948–JANUARY 1951). 12p.

A description of the Brookhaven fuel elements is given along with plating and testing of Al tubes and the machining and canning of U. (W.L.H.)

**17298** TID-2501(Del.)(p.383-94)
Battelle Memorial Inst., Columbus, Ohio.
SOME ASPECTS OF THE RECRYSTALLIZATION OF THORIUM. L. R. Jackson and W. W. Beaver. p.383-94 [of] NUCLEAR SCIENCE AND TECHNOLOGY. (EXTRACTS FROM JOURNAL OF METALLURGY AND CERAMICS. ISSUE NOS. 1 TO 6, JULY 1948–JANUARY 1951). 12p.

This paper is an account of experimental work on the recrystallization of thorium as affected by cold work. It is found that, for thorium cold reduced from 30 to 60%, the recrystallization temperature is in the range 550 to 650°C and the heat of activation for recrystallization is in the order of 44,000 cal/mole. (auth)

**17299** TID-2501(Del.)(p.395-400)
[Ames Lab., Ames, Iowa].
THE PRODUCTION OF THE LIGHT RARE EARTHS IN THE MASSIVE METALLIC STATE. F. H. Spedding, H. A. Wilhelm, W. H. Keller, D. H. Ahmann, A. H. Daane, C. C. Hach, and R. P. Ericson. p.395-400 [of] NUCLEAR SCIENCE AND TECHNOLOGY. (EXTRACTS FROM JOURNAL OF METALLURGY AND CERAMICS. ISSUE NOS. 1 TO 6, JULY 1948–JANUARY 1951). 6p. (AECD-3208; ISC-75).

Also issued separately as AECD-3208 and previously abstracted in NSA, Vol. 5, abstract No. 3208.

**17300** TID-2501(Del.)(p.401-5)
Princeton Univ., N. J.
WHERE ARE WE GOING IN REACTOR DEVELOPMENT? E. P. Wigner. p.401-5 [of] NUCLEAR SCIENCE AND TECHNOLOGY. (EXTRACTS FROM JOURNAL OF METALLURGY AND CERAMICS. ISSUE NOS. 1 TO 6, JULY 1948–JANUARY 1951). 5p. (TID-268(Pt. I)).

At the General Information Meeting held in Oak Ridge in October 1949, Dr. Wigner gave the introductory talk at Session II on the subject "Where Are We Going in Reactor Development?" The interest shown in this talk was such that we thought it appropriate to reproduce it verbatim in the Journal of Metallurgy and Ceramics. (auth)

**17301** TID-2501(Del.)(p.407-24)
Massachusetts Inst. of Tech., Watertown. Mineral Engineering Lab.
THE RECOVERY OF URANIUM FROM LOW-GRADE ORES. A. M. Gaudin, R. Schuhmann, Jr., J. Dasher, R. D. Macdonald, D. Kaufman, J. H. Pannell, and D. R. George. p.407-24 [of] NUCLEAR SCIENCE AND TECHNOLOGY. (EXTRACTS FROM JOURNAL OF METALLURGY AND CERAMICS. ISSUE NOS. 1 TO 6, JULY 1948–JANUARY 1951). 18p. (MITG-243).

Analytical methods for the determination of uranium in low-grade ores are presented. Methods are presented for mineralogical identification, ore dressing, and leaching of ores. A discussion of the economics of the various ore treatments are also included. (W.L.H.)

**17302** TID-2501(Del.)(p.425-40)
Knolls Atomic Power Lab., Schenectady, N. Y.
FEASIBILITY OF PLUTONIUM BREEDING. H. Brooks. p.425-40 [of] NUCLEAR SCIENCE AND TECHNOLOGY. (EXTRACTS FROM JOURNAL OF METALLURGY AND CERAMICS. ISSUE NOS. 1 TO 6, JULY 1948–JANUARY 1951). 16p. (KAPL-M-HB-32).

Following a discussion of the need for breeder development and a summary of the attributes of a power-breeder system, the results of investigations into such factors of breeder design as the capture-to-fission ratio, choice of neutron spectrum, structural materials, poisoning by fission products and Be nuclear reactions, and the enhanced neutron production arising from fast fissions in natural U are reported. Tentative breeding ratios are estimated. (W.L.H.)

**17303** TID-2501(Del.)(p.441-5)
Knolls Atomic Power Lab., Schenectady, N. Y.
VANADIUM AS A POSSIBLE STRUCTURAL METAL IN NUCLEAR REACTORS. Alan U. Seybolt. p.441-5 [of] NUCLEAR SCIENCE AND TECHNOLOGY. (EXTRACTS FROM JOURNAL OF METALLURGY AND CERAMICS. ISSUE NOS. 1 TO 6, JULY 1948–JANUARY 1951). 5p. (KAPL-M-AUS-4).

The low capture cross section coupled with properties such as high melting point, high ductility, and good alloying characteristics with uranium (absence of brittle intermetallic compounds) makes vanadium of interest as a possible structural material in a fast reactor. The present status of vanadium metallurgy, particularly with respect to such a use, is reviewed. (W.L.H.)

**17304** TID-2501(Del.)(p.447-50)
Los Alamos Scientific Lab., N. Mex.
FABRICATION OF URANIUM WIRE. R. E. Anderson, J. N. Taub, and D. T. Doll. p.447-50 [of] NUCLEAR SCIENCE AND TECHNOLOGY. (EXTRACTS FROM JOURNAL OF METALLURGY AND CERAMICS. ISSUE NOS. 1 TO 6, JULY 1948–JANUARY 1951). 4p. (LAMS-967).

Also issued separately as LAMS-967 and previously abstracted in NSA, Vol. 11, Abstract No. 11829.

**17305** TID-2501(Del.)(p.451-4)
Ames Lab., Ames, Iowa.
FABRICATION OF LARGE BERYLLIA CRUCIBLES. W. E. Hauth and H. A. Wilhelm. p.451-4 [of] NUCLEAR SCIENCE AND TECHNOLOGY. (EXTRACTS FROM JOURNAL OF METALLURGY AND CERAMICS. ISSUE NOS. 1 TO 6, JULY 1948–JANUARY 1951). 4p. (ISC-117).

A method for the production of a large thin-walled beryllium oxide crucible for metal melting and casting is described. The piece is formed by jolt-packing in a graphite mold, and is fired in an induction furnace. The important factors is overcoming warpage and cracking are the use of electrically fused beryllia grain and the proper particle-size distribution of the grain to give a close-packed system. Addition of CaO is made to the beryllia to produce a hard abrasion-resistant crucible at a firing temperature of approximately 1900°C. Crucibles

formed by this method undergo about 3 to 5% firing shrinkage and have a porosity of roughly 20%. (auth)

**17306** TID-2501(Del.)(p.455-521)
Knolls Atomic Power Lab., Schenectady, N. Y.
PROBLEMS IN THE USE OF MOLTEN SODIUM AS A HEAT TRANSFER FLUID. PART II. Leo F. Epstein and Clifford E. Weber. p.455-521 [of] NUCLEAR SCIENCE AND TECHNOLOGY. (EXTRACTS FROM JOURNAL OF METALLURGY AND CERAMICS. ISSUE NOS. 1 TO 6, JULY 1948-JANUARY 1951). 67p. (KAPL-362).

A procedure for the fabrication of uranium wire was developed. The method consisted in swaging 0.500-in.-diameter silver-plated uranium rod to 0.042-in.-diameter. The swaged rod was annealed in vacuum at 400°C after each 75 per cent reduction in area. Reduction from 0.042-in.-diameter was accomplished by wire-drawing, using Aquadag as a lubricant. The wire was annealed in vacuum at 400°C after each 75 per cent reduction in area. Wire was produced to 0.0033-in. diameter in tuballoy and to 0.010-in. diameter in enriched uranium ($U^{235}$). There was no apparent difference in workability between natural uranium and $U^{235}$. (auth)

**17307** TID-2501(Del.)(p.523-4)
Knolls Atomic Power Lab., Schenectady, N. Y.
NOTE ON THE CRYSTAL STRUCTURE OF BETA-URANIUM. Joseph S. Lukesh. p.523-4 [of] NUCLEAR SCIENCE AND TECHNOLOGY. (EXTRACTS FROM JOURNAL OF METALLURGY AND CERAMICS. ISSUE NOS. 1 TO 6, JULY 1948-JANUARY 1951). 2p. (KAPL-M-JSL-4).

A discussion is presented on the crystal structure of beta uranium. (W.L.H.)

**17308** TID-2501(Del.)(p.525-7)
Massachusetts Inst. of Tech., Cambridge.
THE THERMAL EXPANSION CHARACTERISTICS OF BERYLLIUM AS MEASURED WITH A HIGH TEMPERATURE PRECISION X-RAY CAMERA. Paul Gordon. p.525-7 [of] NUCLEAR SCIENCE AND TECHNOLOGY. (EXTRACTS FROM JOURNAL OF METALLURGY AND CERAMICS. ISSUE NOS. 1 TO 6, JULY 1948-JANUARY 1951). 3p. (MIT-PG-9).

The thermal-expansion coefficients of Be were measured up to 1000°C. (W.L.H.)

**17309** TID-2501(Del.)(p.529-30)
Battelle Memorial Inst., Columbus, Ohio.
DISCUSSION ON "RECRYSTALLIZATION OF COLD-ROLLED URANIUM," BY E. E. HAYES. L. R. Jackson. p.529-30 [of] NUCLEAR SCIENCE AND TECHNOLOGY. (EXTRACTS FROM JOURNAL OF METALLURGY AND CERAMICS. ISSUE NOS. 1 TO 6, JULY 1948-JANUARY 1951.) 2p.

Data are presented on the recrystallization of uranium cold rolled 85%. (W.L.H.)

**17310** TID-2501(Del.)(p.531-2)
Knolls Atomic Power Lab., Schenectady, N. Y.
NOTE ON THE CRYSTAL STRUCTURE OF GRAPHITE. Joseph S. Lukesh. p.531-2 [of] NUCLEAR SCIENCE AND TECHNOLOGY. (EXTRACTS FROM JOURNAL OF METALLURGY AND CERAMICS. ISSUE NOS. 1 TO 6, JULY 1948-JANUARY 1951.) 2p.

A brief discussion is presented on the crystal structure of graphite. (W.L.H.)

**17311** TID-2502(Del.)
Technical Information Service, AEC.
NUCLEAR SCIENCE AND TECHNOLOGY. (EXTRACTS FROM REACTOR SCIENCE AND TECHNOLOGY. VOL. 1, ISSUES 1 TO 3, APRIL-DECEMBER 1951). Decl. with deletions Mar. 11, 1957. 362p. $41.40(ph OTS); $11.10(mf OTS).

About twenty five papers are included in this issue. Separate abstracts have been prepared for each paper. (W.L.H.)

**17312** TID-2502(Del.)(p.1-6)
Division of Reactor Development, AEC.
THE REACTOR PROGRAM. George L. Weil. p.1-6 [of] NUCLEAR SCIENCE AND TECHNOLOGY. (EXTRACTS FROM REACTOR SCIENCE AND TECHNOLOGY. VOL. 1, ISSUES 1 TO 3, APRIL-DECEMBER 1951.) 6p.

The AEC program for developing nuclear reactors for power purposes is discussed in two categories: mobile power plants for military purposes, and central-station plants. The status of research and development at the various AEC laboratories is briefly summarized. The type of reactor and related problems being studied by each are stated without detail. (W.L.H.)

**17313** TID-2502(Del.)(p.7-26)
Sylvania Electric Products Inc. Metallurgical Labs., Bayside, N. Y.
THE APPLICATION OF POWDER METALLURGY TO PROBLEMS INVOLVING BERYLLIUM, ZIRCONIUM, AND URANIUM. B. H. Alexander, H. H. Hausner, and W. E. Kingston. p.7-26 [of] NUCLEAR SCIENCE AND TECHNOLOGY. (EXTRACTS FROM REACTOR SCIENCE AND TECHNOLOGY. VOL. 1, ISSUES 1 TO 3, APRIL-DECEMBER 1951). 20p. (SEP-51(X)).

The advantages of powder metallurgy in certain applications are discussed, and the methods that have been developed for making, pressing, and sintering powders of uranium, beryllium, and zirconium are outlined. Special applications of these methods in the production of fuel elements, in the control of grain size and orientation, in the introduction of discrete particles in a metallic matrix, and in research on phase diagrams, diffusion, homogenization, and alloy development are reviewed. (auth)

**17314** TID-2502(Del.)(p.27-42)
Oak Ridge National Lab., Tenn.
SOME LONG-RANGE ASPECTS OF HOMOGENEOUS REACTORS. J. A. Lane. p.27-42 [of] NUCLEAR SCIENCE AND TECHNOLOGY. (EXTRACTS FROM REACTOR SCIENCE AND TECHNOLOGY. VOL. 1, ISSUES 1 TO 3, APRIL-DECEMBER 1951). 14p. (ORNL-946(Del.)).

If homogeneous reactors can be made to work, they offer many worthwhile possibilities for the production of power and fissionable material. Consequently, a solution of the technical problems associated with homogeneous systems is extremely important for the long-range reactor program. The construction and operation of the proposed Homogeneous Reactor Experiment is the first major step in this direction, and the success of this experimental reactor will pave the way toward fuller utilization of the advantages of homogeneous or fluid systems. The problem of reducing the cost of power from nuclear reactors is essentially one of reducing the capital cost of the reactor and its associated equipment. For this reason homogeneous reactors, by virtue of their fundamental simplicity and high possible power output, offer the best chance of achieving competitive industrial power. The importance of initiating studies directed toward the development of a suitable thorium system should be emphasized, since a $U^{233}$-thorium thermal power breeder is potentially the most attractive possibility for economic power of the many systems considered. (auth)

**17315** TID-2502(Del.)(p.43-66)
North American Aviation, Inc., Downey, Calif.
ON THE HAZARD DUE TO NUCLEAR REACTORS. M. M. Mills. p.43-66 [of] NUCLEAR SCIENCE AND TECHNOLOGY. (EXTRACTS FROM REACTOR SCIENCE AND TECHNOLOGY. VOL. 1, ISSUES 1 TO 3, APRIL–DECEMBER 1951). 24p. (NAA-SR-116 (Del. 2)).

The hazard of possible contamination of the atmosphere or water supply by the release of the radioactive materials contained within a reactor core is considered from the standpoint of the technological sequence of events leading to the release. Three possible mechanisms of reactor catastrophe are discussed, namely, mechanical disruption, cooling failure, and reactor runaway, with sabotage the most probable cause of the first. Since a reactor shield is a massive structure, and only to be breached by an improbable amount of explosives, and since a catastrophe would almost surely be a nonexplosive release, an adequately gas-tight reactor building is likely to remove the public hazard. (W.L.H.)

**17316** TID-2502(Del.)(p.67-80)
Massachusetts Inst. of Tech., Watertown. Mineral Engineering Lab.
PRODUCTION OF A HIGH-GRADE URANIUM PRECIPITATE FROM ORE LEACH SOLUTIONS. A. M. Gaudin, John Dasher, David Kaufman, Sara E. Bailey, and Norman N. Schiff. p.67-80 [of] NUCLEAR SCIENCE AND TECHNOLOGY. (EXTRACTS FROM REACTOR SCIENCE AND TECHNOLOGY. VOL. 1, ISSUES 1 TO 3, APRIL–DECEMBER 1951). 14p. (MITG-254).

The recovery of uranium from Witwatersrand gold ores has received special attention both because of the probable future importance of these ores as a source and because of the difficulty caused by their very low grade (about 0.02 per cent $U_3O_8$). Several methods are described for the retreating of the low-grade precipitates from leaching solutions. These methods include (1) acid digestion, resulting in a 10- to 50-fold increase in uranium concentration, followed by peroxide precipitation, (2) carbonate leaching followed by acidification to remove carbonate and then by neutralization to precipitate a high-grade product, and (3) leaching with nitrated ether followed by neutralization with $NH_3$ to precipitate uranium hydroxide and ammonium nitrate and by a water leach to remove the latter. Various methods are described for the removal of uranium directly from the leach liquor, the most promising being (1) reduction and pyrophosphate precipitation and (2) adsorption on strong-base anion-exchange resins. Pilot plants using the ion-exchange method are now in operation on the Rand. (auth)

**17317** TID-2502(Del.)(p.81-97)
Hydrocarbon Research, Inc., New York and Westinghouse Electric Corp., Pittsburgh.
SURVEY OF PROCESSES FOR SEPARATION OF THE PRODUCTS OF NUCLEAR REACTORS. J. H. Arnold, M. Benedict, J. A. Finneran, S. Golden, and F. B. Grosselfinger. p.81-97 [of] NUCLEAR SCIENCE AND TECHNOLOGY. (EXTRACTS FROM REACTOR SCIENCE AND TECHNOLOGY. VOL. 1, ISSUES 1 TO 3, APRIL–DECEMBER 1951). 17p. (TID-458(Del.)).

The primary objective of the subject survey has been the evaluation of separation processes, for future installations, for recovering and decontaminating plutonium and uranium from irradiated natural uranium and concentrating the residual radioactive waste. In addition, processes have been considered for treating enriched uranium and for handling the cores and blankets of plutonium and $U^{233}$ breeders. Processes are evaluated from the standpoints of efficiency of recovery and decontamination of plutonium and uranium, concentration of fission products, probability of success on a production scale, capital cost, operating cost, and hazard. (auth)

**17318** TID-2502(Del.)(p.99-112)
Massachusetts Inst. of Tech., Watertown. Mineral Engineering Lab.
LYOMETALLURGY: A NEW METHOD OF EXTRACTING URANIUM FROM ITS ORES. A. M. Gaudin, F. W. Bloecher, Jr., John Dasher, David Kaufman, Paul Galvanek, Jr., and William V. Ward. p.99-112 [of] NUCLEAR SCIENCE AND TECHNOLOGY. (EXTRACTS FROM REACTOR SCIENCE AND TECHNOLOGY. VOL. 1, ISSUES 1 TO 3, APRIL–DECEMBER 1951.) 14p. (MITG-260).

Lyometallurgy is a metallurgical leaching process in which an organic solvent, initially free of a separate water phase, is used to leach a dry or slightly damp solid. Because of the solubility characteristics of uranyl nitrate, most of the test work has been done with ethyl ether and nitric acid. Most of the laboratory work to date has been concerned with testing the efficacy of lyometallurgical leaching on a large number of U-bearing raw materials and plant products. Consequently, a good deal of study has been devoted to the matter of pretreatment and leaching, but not too much effort has been spent on the study of solvent stripping, regeneration, and reagent recovery. Results of lyometallurgical investigation have shown that the method is an attractive alternative to acid leaching for beneficiation of U ores. Various flowsheets are given, and some over-all process cost estimates are made. (auth)

**17319** TID-2502(Del.)(p.113-29)
Brookhaven National Lab., Upton, N. Y.
THE HOT LABORATORY AT BROOKHAVEN NATIONAL LABORATORY. W. E. Winsche, L. G. Stang, Jr., Gerald Strickland, P. Richards, G. J. Selvin, F. Horn, and G. Bennett. p.113-29 [of] NUCLEAR SCIENCE AND TECHNOLOGY. (EXTRACTS FROM REACTOR SCIENCE AND TECHNOLOGY. VOL. 1, ISSUES 1 TO 3, APRIL–DECEMBER 1951). 17p. (TID-5020).

The Hot Laboratory has been specifically designed and built to handle and process multicurie amounts of radioactive materials. It is operated by a permanent staff in such a way that others can also use the various facilities required for this type of work. A wide variety of facilities is available, and use is already being made of them as indicated by the scope of the research and operations program presently under way. The general philosophy used in designing the buildings is outlined, and the facilities themselves are described in detail. (auth)

**17320** TID-2502(Del.)(p.131-46)
Argonne National Lab., Lemont, Ill.
THE EXPONENTIAL EXPERIMENTS AT ARGONNE NATIONAL LABORATORY. A. H. Barnes, B. Hamermesh, B. I. Spinrad, C. Kimball, and N. L. Krisberg. p.131-46 [of] NUCLEAR SCIENCE AND TECHNOLOGY. (EXTRACTS FROM REACTOR SCIENCE AND TECHNOLOGY. VOL. 1, ISSUES 1 TO 3, APRIL–DECEMBER 1951). 16p. (TID-5025(Del.)).

The general theory of the exponential experiment is discussed, together with the detailed information available on a series of exponential experiments taking place at Argonne. Data from a typical experiment are presented. (auth)

**17321** TID-2502(Del.)(p.147-62)
North American Aviation, Inc., Downey, Calif.
A HIGH-TEMPERATURE REACTOR FOR POWER BREEDER APPLICATION. Sidney Siegel. p.147-62 [of] NUCLEAR SCIENCE AND TECHNOLOGY. (EXTRACTS FROM REACTOR SCIENCE AND TECHNOLOGY. VOL. 1, ISSUES 1 TO 3, APRIL-DECEMBER 1951). 16p. (NAA-SR-147(Del.)).

A particular example, a graphite core homogeneously impregnated with $U^{233}$ as the carbide, is shown to have attractive possibilities as a power breeder. A liquid-Bi-cooled design is discussed with a doubling time of approximately 300 days. Of prime importance for such an application is the chemical processing cycle, and means whereby this may be reduced in duration are described which apply particularly to the type of reactor fuel structure under consideration. (auth)

**17322** TID-2502(Del.)(p.163-82)
Brookhaven National Lab., Upton, N. Y.
PROBLEMS OF RADIATION DAMAGE IN LIQUIDS. A. O. Allen. p.163-82 [of] NUCLEAR SCIENCE AND TECHNOLOGY. (EXTRACTS FROM REACTOR SCIENCE AND TECHNOLOGY. VOL. 1, ISSUES 1 TO 3, APRIL-DECEMBER 1951.) 20p. (BNL-1012(Del.)).

Current research is surveyed on (1) basic studies of chemical-reaction mechanisms, rates of energy transfer, and modes of excitation of molecules by radiation; (2) materials testing and development, i.e., more or less empirical studies of the ways in which properties of materials are affected by radiation, development of materials more radiation resistant than those currently at hand, and development of practical uses for radiations; (3) reactor-component testing, which is essentially materials testing under the specific conditions which are to obtain at some particular point of a particular proposed reactor. Work on effects of radiation on homogeneous-reactor solutions, coolant or moderator water, and separation processes is reviewed briefly, and future investigations are recommended. (auth)

**17323** TID-2502(Del.)(p.183-200)
California Research Corp., Richland, Calif.
THE EFFECTS OF FISSION RADIATIONS ON LUBRICANTS AND LUBRICATION. R. O. Bolt, J. G. Carroll, and G. H. Denison. p.183-200 [of] NUCLEAR SCIENCE AND TECHNOLOGY. (EXTRACTS FROM REACTOR SCIENCE AND TECHNOLOGY. VOL. 1, ISSUES 1 TO 3, APRIL-DECEMBER 1951). 18p. (TID-5045(Del.)).

Part I—Oxidation Tests. These experiments were undertaken to evaluate the stability of organic fluids to pile radiations and to excess oxygen. The oxidative condition simulated that present in turbojet lubricating systems where high temperature air is present in excess. Many thermal oxidation tests were conducted in the absence of radiations on selected base oils and base oil-additive combinations. Eleven in-pile experiments were performed under comparable conditions on the most promising formulations. Oxidations of previously irradiated fluids were also conducted in the absence of radiations. The results observed are presented as they relate to the stability of various base oils, the effect of radiations, and the effect of additives. Part II—Bearing Lubrication Tests. These tests were conducted to investigate the effect in open systems, of pile radiations on the lubrication process and on lubricants operating standard bearings, bushings, and gears. Lubricants from three basic types of synthetic oils were employed in experiments designed to demonstrate the feasibility of using such materials in functional equipment. The base oils and additives had been demonstrated superior in static irradiations and oxidation tests in the X-10 pile. Three units, in which ball bearings were driven with air turbines, were operated in the reactor for 500 hr at 10,000 rpm. Three moter-driven units in which ball bearings, journal bearings, and gears were used were also operated in the reactor for 100 hr at 80 rpm. Each of the six in-pile tests was duplicated in the absence of radiations to obtain reference results. Data on mechanical changes in the operating parts and on deterioration of the lubricants are presented and discussed. (auth)

**17324** TID-2502(Del.)(p.201-15)
Oak Ridge National Lab., Tenn.
A SURVEY OF HOMOGENEOUS-REACTOR CHEMICAL PROCESSING. F. R. Bruce. p.201-15 [of] NUCLEAR SCIENCE AND TECHNOLOGY. (EXTRACTS FROM REACTOR SCIENCE AND TECHNOLOGY. VOL. 1, ISSUES 1 TO 3, APRIL-DECEMBER 1951). 15p. (ORNL-1136(Rev.2)(Del.)).

Major problems involved in homogeneous-reactor chemical processing are presented. Chemical processing for treating a homogeneous Pu producer is discussed and a process is proposed consisting of coupling continuous Pu removal by ion exchange to U decontamination by tributyl phosphate extraction. (W.L.H.)

**17325** TID-2502(Del.)(p.217-20)
North American Aviation, Inc., Downey, Calif.
AN ENGINEERING TEST REACTOR. T. Fahrner, R. L. Stoker, and A. S. Thompson. p.217-20 [of] NUCLEAR SCIENCE AND TECHNOLOGY. (EXTRACTS FROM REACTOR SCIENCE AND TECHNOLOGY. VOL. 1, ISSUES 1 TO 3, APRIL-DECEMEER 1951.) 4p. (NAA-SR-Memo-32(Del.)).

A relatively inexpensive reactor for the specific purpose of testing (by sustaining the neutron leakage of the test assembly) a subcritical portion of another reactor under conditions that would exist during actual operation is discussed. It is concluded that an engineering tool for reactor development work that bridges the present gap between exponential and criticality experiments and the actual full-scale operating reactor is feasible. An example of such a test reactor which would not entail development effort to put into operation is depicted. (W.L.H.)

**17326** TID-2502(Del.)(p.221-5)
Knolls Atomic Power Lab., Schenectady, N. Y.
A NOTE ON THE DUCTILITY OF BETA URANIUM. A. N. Holden. p.221-5 [of] NUCLEAR SCIENCE AND TECHNOLOGY. (EXTRACTS FROM REACTOR SCIENCE AND TECHNOLOGY. VOL. 1, ISSUES 1 TO 3, APRIL-DECEMBER 1951). 5p. (KAPL-408).

Beta uranium is not a brittle phase. It deforms readily by slip on at least one slip system. It may be hot worked if reasonable care is taken to avoid transformations by accurate control of the temperature of working. Single crystals are very ductile. (W.L.H.)

**17327** TID-2502(Del.)(p.227-8)
Knolls Atomic Power Lab., Schenectady, N. Y. and Battelle Memorial Inst., Columbus, Ohio.
TENTATIVE URANIUM-TITANIUM PHASE DIAGRAM. A. U. Seybolt, D. W. White, F. W. Boulger, and M. C. Udy. p.227-8 [of] NUCLEAR SCIENCE AND TECHNOLOGY. (EXTRACTS FROM REACTOR SCIENCE AND TECHNOLOGY. VOL. 1, ISSUES 1 TO 3, APRIL-DECEMBER 1951). 2p. (KAPL-470).

A phase diagram for U-Ti sheet is based on a rather rough survey by thermal analysis, microscopic examination, dilatometric measurements, and x-ray-diffrac-

tion. While many of the regions are still in considerable doubt, the major phase fields are thought to be correct on a semiquantitative basis. The compound $U_2Ti$, dividing the diagram into two parts, has a hexagonal crystal structure and melts at an estimated 2000°C. (W.L.H.)

**17328** TID-2502(Del.)(p.229-31)
Knolls Atomic Power Lab., Schenectady, N. Y.
HOMOPOLAR GENERATOR PUMP. L. B. Vandenburg. p.229-31 [of] NUCLEAR SCIENCE AND TECHNOLOGY. (EXTRACTS FROM REACTOR SCIENCE AND TECHNOLOGY. VOL. 1, ISSUES 1 TO 3, APRIL–DECEMBER 1951). 3p. (TID-5004(Del.)).

This report presents the results of combining a homopolar generator and a simple d-c electromagnetic liquid metal pump in one unit. An experimental pump proved the feasibility of such a combination, and it also proved that compact pumps of high efficiency can be built. The problems usually presented by bearings, seals, heavy bus-bar connections, lead losses, and bulky power-conversion equipment, which are associated with the pumping of liquid metal, are largely eliminated. (auth)

**17329** TID-2502(Del.)(p.233-4)
California. Univ., Berkeley. Radiation Lab.
ON THE REMOVAL OF $Na_2O$ FROM Na BY DISTILLATION. Leo Brewer and John L. Margrave. p.233-4 [of] NUCLEAR SCIENCE AND TECHNOLOGY. (EXTRACTS FROM REACTOR SCIENCE AND TECHNOLOGY. VOL. 1, ISSUES 1 TO 3, APRIL–DECEMBER 1951.) 2p. (UCRL-1241(Rev.)).

Results of earlier investigations of the distillation of a Na-$Na_2O$ solution are discussed. An explanation is offered which could account for the removal of O from the still-pot residue which is observed to be leaner in O than the initial feed. 5 references. (W.L.H.)

**17330** TID-2502(Del.)(p.235-6)
North American Aviation, Inc., Downey, Calif.
TEMPERATURE EFFECT IN $D_2O$-URANIUM LATTICES. A. T. Biehl and E. R. Cohen. p.235-6 [of] NUCLEAR SCIENCE AND TECHNOLOGY. (EXTRACTS FROM REACTOR SCIENCE AND TECHNOLOGY, VOL. 1. ISSUES 1 TO 3, APRIL–DECEMBER 1951.) 2p. (TID-5029).

By comparing the flux distribution in similar multiplying and nonmultiplying lattices the relative mean neutron velocities in these lattices and the effective temperature have been determined. The multiplying lattice consisted of U rods clad in Al tubes while the nonmultiplying lattice was achieved by replacing the U with a Pb-Cd alloy. These measurements were checked through the use of Eu foils which had been calibrated against Au foils in a thermal flux. (W.L.H.)

**17331** TID-2502(Del.)(p.237-41)
Brookhaven National Lab., Upton, N. Y.
EQUILIBRIUM IN THE EXCHANGE OF DEUTERIUM BETWEEN AMMONIA AND HYDROGEN (PART I). Morris Perlman, Jacob Bigeleisen, and Norman Elliott. p.237-41 [of] NUCLEAR SCIENCE AND TECHNOLOGY. (EXTRACTS FROM REACTOR SCIENCE AND TECHNOLOGY. VOL. 1, ISSUES 1 TO 3, APRIL–DECEMBER 1951). 5p. (BNL-1007).

Equilibrium in the reaction $NH_{3(g)} + HD_{(g)} = NH_2D_{(g)} + H_{2(g)}$ was measured in the temperature range 210 to 295°K. The results may be expressed by the relation $K = 0.955 \exp 512/T$. The zero point energy difference between $NH_3$ and $NH_2D$ is calculated. (auth)

**17332** TID-2502(Del.)(p.243-5)
Ames Lab., Ames, Iowa.
A TECHNIQUE FOR PRODUCING FINE-PARTICLE THORIUM OXIDE AND URANIUM OXIDE. Robert S. Hansen and Robert E. Minturn. p.243-5 [of] NUCLEAR SCIENCE AND TECHNOLOGY. (EXTRACTS FROM REACTOR SCIENCE AND TECHNOLOGY. VOL. 1, ISSUES 1 TO 3, APRIL–DECEMBER 1951.) 3p. (ISC-145).

Oxides of U and Th with particles averaging less than 75 mμ in diameter have been prepared by combustion of atomized solutions of the corresponding nitrates in organic solvents (chiefly acetone). Using these procedures, yields ~25% of theoretical maximum were obtained. An x-ray powder photograph of the U oxide indicates it to be about 70% $U_2O_5$. (auth)

**17333** TID-2502(Del.)(p.247-8)
Battelle Memorial Inst., Columbus, Ohio.
THE VANADIUM–URANIUM CONSTITUTIONAL DIAGRAM. H. A. Saller and F. A. Rough. p.247-8 [of] NUCLEAR SCIENCE AND TECHNOLOGY. (EXTRACTS FROM REACTOR SCIENCE AND TECHNOLOGY. VOL. 1, ISSUES 1 TO 3, APRIL–DECEMBER 1951). 2p. (BMI-HAS-4).

The V–U constitutional diagram has been determined on alloys prepared from high-purity iodide V and good biscuit U. No intermetallic phases occur in the system. Additions of V lower the U melting point and transformations producing a eutectic and eutectoid reactions. The maximum solubility of U in V is given. (auth)

**17334** TID-2502(Del.)(p.249-51)
Oak Ridge National Lab., Tenn.
ANODIC AND CATHODIC TREATMENT OF TYPE 347 STAINLESS STEEL DURING PASSIVATION WITH NITRIC ACID OR CHROMIC ACID SOLUTIONS. M. H. Lietzke. p.249-51 [of] NUCLEAR SCIENCE AND TECHNOLOGY. (EXTRACTS FROM REACTOR SCIENCE AND TECHNOLOGY. VOL. 1, ISSUES 1 TO 3, APRIL–DECEMBER 1951). 3p. (CF-51-10-141).

The possibility of the use of anodic or cathodic treatment of type 347 stainless steel during passivation with nitric acid or chromic acid solutions is investigated. It is shown that such treatment actually produces passive films which are inferior to those produced without such treatment. (W.L.H.)

**17335** TID-2502(Del.)(p.253-8)
Oak Ridge National Lab., Tenn.
THE MEASUREMENT OF THE SOLUBILITY OF FISSION-PRODUCT SULFATES AT HIGH TEMPERATURES AND PRESSURES. M. H. Lietzke. p.253-8 [of] NUCLEAR SCIENCE AND TECHNOLOGY. (EXTRACTS FROM REACTOR SCIENCE AND TECHNOLOGY. VOL. 1, ISSUES 1 TO 3, APRIL–DECEMBER 1951). 6p. (CF-51-10-142).

The solubilities of several fission-product (La, Cd, Zn, Cs, and Y) sulfates have been measured at high temperatures and pressures both in water and in 0.13 formal uranyl sulfate solution. The measurements were made by the quartz tube method which depends upon the visual observation of the appearance or disappearance of crystals in synthetic "mixtures" of known concentration. (auth)

**17336** TID-2502(Del.)(p.259-62)
Battelle Memorial Inst., Columbus, Ohio.
NOTES ON COMMERCIAL CARBON AND GRAPHITE. J. A. Slyh. p.259-62 [of] NUCLEAR SCIENCE AND TECHNOLOGY. (EXTRACTS FROM REACTOR SCIENCE AND TECHNOLOGY. VOL. 1, ISSUES 1 TO 3, APRIL–DECEMBER 1951). 4p. (TID-5046).

Brief note is made of the importance of carbon and graphite parts in the industrial world and in the work of the AEC, and of the considerable amount of study being

expended on the material. The more common physical characteristics, and the raw materials and processing operations employed in the fabrication, of many of the commercial grades of the National Carbon Division of the Union Carbide and Carbon Corporation are presented in a table. Typical properties of the carbon and graphite products of the Great Lakes Carbon Corp. and of the International Graphite and Electrode Corp. are also tabulated. (W.L.H.)

**17337** TID-2503(Del.)
Technical Information Service, AEC.
NUCLEAR SCIENCE AND TECHNOLOGY. (EXTRACTS FROM REACTOR SCIENCE AND TECHNOLOGY. VOL. 2, ISSUES 1 TO 4, APRIL–DECEMBER 1952.) Decl. with deletions June 10, 1958. 469p. $75.60(ph OTS); $11.10(mf OTS).

Thirty-three articles are included in this issue. Separate abstracts have been prepared for each article. (T.R.H.)

**17338** TID-2503(Del.)(p.1-12)
Brookhaven National Lab., Upton, N. Y.
FLUID FUEL REACTORS WITH URANIUM–BISMUTH. F. T. Miles, D. W. Bareis, O. E. Dwyer, D. H. Gurinsky, I. Kaplan, R. J. Teitel, and C. Williams. p.1-12 [of] NUCLEAR SCIENCE AND TECHNOLOGY. (EXTRACTS FROM REACTOR SCIENCE AND TECHNOLOGY. VOL. 2, ISSUES 1 TO 4, APRIL–DECEMBER 1952). 12p. (BNL-1072; LFR-4).

Uranium–bismuth solutions or dispersions of $USn_3$ in liquid bismuth–lead–tin are proposed as fluid fuels for a power breeder or converter. These fuels offer advantages of high specific power, unlimited burn-up, good neutron economy, and low over-all operating costs which might lead to truly economical nuclear power. A simple and effective chemical process based on the extraction of liquid metal with fused salts will remove fission products in a concentrated form for use or storage. A process for the continuous separation of $U^{233}$ from thorium in the blanket is described. Several design possibilities are discussed. (auth)

**17339** TID-2503(Del.)(p.13-19)
Nuclear Development Associates, Inc., White Plains, N. Y.
MINIMUM CRITICAL MASS AND FLAT FLUX. Gerald Goertzel. p.13-19 [of] NUCLEAR SCIENCE AND TECHNOLOGY. (EXTRACTS FROM REACTOR SCIENCE AND TECHNOLOGY. VOL. 2, ISSUES 1 TO 4, APRIL–DECEMBER 1952). 7p. (CF-52-2-9).

The problem of distributing fuel in a homogeneous moderator region so as to obtain a reactor of minimum critical mass is set up and a solution is obtained for thermal reactors. The condition for minimum critical mass is found to be constant thermal flux in the region where there is fuel (the core) with the thermal flux never greater than this constant value where there is no fuel (the reflector). It is necessary to solve an integral equation to find the fuel distribution. The size and shape of the core region is determined from this integral equation. An explicit solution is given for the multigroup reactor model. The minimum problem is also considered with certain restrictions, such as confining the core to a given region. Further, the minimum critical mass for $U^{235}$ in light water is computed (with infinite reflector) and found to be 30 per cent less than the corresponding best value for a uniform fuel distribution in the core. (auth)

**17340** TID-2503(Del.)(p.21-51)
Brush Beryllium Co., Cleveland.
PRODUCTION OF BERYLLIUM AND ITS COMPOUNDS FOR REACTOR USE. Wallace W. Beaver. p.21-51 [of] NUCLEAR SCIENCE AND TECHNOLOGY. (EXTRACTS FROM REACTOR SCIENCE AND TECHNOLOGY. VOL. 2, ISSUES 1 TO 4, APRIL–DECEMBER 1952). 31p. (NYO-1110(Del.)).

Beryllium products have been made for the AEC continuously over a period of about two years. Standard and special materials and fabricated parts have been made available to the various reactor sites, and for use in the MTR and SIR-PPA (Mark B and PPA) reactors. The production processes are based on sulfate extraction of the ore, reduction of beryllium fluoride, and fabrication of finished parts through powder metallurgy and/or extrusion, rolling, and machining. Methods for making and fabricating beryllium oxide and beryllium carbide are described. Auxiliary matters important to the beryllium industry, such as ore supply and health problems, are discussed. Typical reactor parts made from beryllium and their physical, mechanical, and chemical properties, especially relating to their use in nuclear reactors, are shown. Relative costs of beryllium at various stages of production and fabrication, as well as the specifications for beryllium products, are presented. (auth)

**17341** TID-2503(Del.)(p.53-67)
California Research Corp., Richmond, Calif.
THE EFFECTS OF FISSION RADIATIONS ON LUBRICANTS AND LUBRICATION. R. O. Bolt, J. G. Carroll, and G. H. Denson. p.53-67 [of] NUCLEAR SCIENCE AND TECHNOLOGY. (EXTRACTS FROM REACTOR SCIENCE AND TECHNOLOGY. VOL. 2, ISSUES 1 TO 4, APRIL–DECEMBER 1952.) 14p. (TID-5074(Del.2)).

Organic fluids in vented and in sealed containers were exposed not only to combined reactor radiations but also to gamma radiations alone under various conditions. Changes in physical properties of simple and compounded fluids were compared with similar changes found to occur under the same conditions but in the absence of radiations. Chemical configurations relatively resistant to deterioration by radiations were thus revealed. Base oils and base oil–additive combinations disclosed in this way were developed further into lubricant formulations. Effects of temperature, flux magnitude, and dosage were investigated in the irradiation of compounded hydrocarbons, esters, and ethers. The data are presented as they apply generally to organic fluids. (auth)

**17342** TID-2503(Del.)(p.69-76)
North American Aviation, Inc., Downey, Calif.
A WATER-BOILER REACTOR AS A SOURCE OF NEUTRONS FOR EXPONENTIAL EXPERIMENTS. A. T. Biehl, T. Fahrner, and S. Kash. p.69-76 [of] NUCLEAR SCIENCE AND TECHNOLOGY. (EXTRACTS FROM REACTOR SCIENCE AND TECHNOLOGY. VOL. 2, ISSUES 1 TO 4, APRIL–DECEMBER 1952.) 8p. (NAA-SR-Memo-358(Del.)).

The design of the low-power water-boiler reactor at the Atomic Energy Research Department of North American Aviation is described. Comparison as neutron sources is made between radioactive sources, neutron beams from $\alpha$, d, and p reactions, and various reactors. The reactor described compares favorably with radioactive and beam type sources with regard to cost, flexibility, and neutrons available. (auth)

**17343** TID-2503(Del.)(p.77-83)
Division of Reactor Development, AEC.
THE APPROACH TO THE DEVELOPMENT OF POWER REACTORS. Henry Ott. p.77-83 [of] NUCLEAR SCIENCE AND TECHNOLOGY. (EXTRACTS FROM REAC-

TOR SCIENCE AND TECHNOLOGY. VOL. 2, ISSUES 1 TO 4, APRIL–DECEMBER 1952). 7p. (TID-5092 (Del. 2)).

By-product yield should not be an essential feature of reactors designed primarily for the production of economic industrial power, and any useful by-products should be credited only with their market value in a peacetime economy. Whether power reactors should be true breeders is a matter of economic advantage only since ore availability is largely determined by the price offered. Long operating life for fuel elements and really cheap chemical processing, as may be possible for fluid-fuel reactors, are more important. High load factors are essential because of large investment costs. Reactor types showing promise of development as power reactors are discussed, among them heavy- and light-water-moderated, liquid-metal-cooled, gas-cooled, fast or intermediate, and fluid-fuel reactors. Major developmental problems are mentioned. (auth)

**17344** TID-2503(Del.)(p.85-108)
Brookhaven National Lab., Upton, N. Y.
EVALUATION OF REACTOR DESIGNS. F. T. Miles and I. Kaplan. p.85-108 [of] NUCLEAR SCIENCE AND TECHNOLOGY. (EXTRACTS FROM REACTOR SCIENCE AND TECHNOLOGY. VOL. 2, ISSUES 1 TO 4, APRIL–DECEMBER 1952). 24p. (BNL-1159(Del. 2); LMFR-5(Del. 2)).

Some objective criteria are defined which can be used to evaluate and compare reactors. These criteria are developed through consideration of neutron economy, fissionable-material economy, total heat rate or power level, useful power, and dollar economy. Examples are used to show how emphasis on one criterion affects design. The change of emphasis in the past is traced, and some estimate of future trends is made. (auth)

**17345** TID-2503(Del.)(p.109-20)
Argonne National Lab., Lemont, Ill.
REACTOR WATER-QUALITY CONTROL. Michael Sivetz and C. H. Scheibelhut. p.109-20 [of] NUCLEAR SCIENCE AND TECHNOLOGY. (EXTRACTS FROM REACTOR SCIENCE AND TECHNOLOGY. VOL. 2, ISSUES 1 TO 4, APRIL–DECEMBER 1952.) 11p. (ANL-ABS-53(Rev.2)(Del.2)).

Because numerous water-cooled reactors are now in use or under design and construction, considerable interest has been aroused in the engineering of reactor water-purification systems. To disseminate useful experimental data to interested groups who are located at various places and with different organizations in this field, the purposes, techniques, and formulations for keeping cycling reactor-cooling or moderator waters pure and operable under intense reactor neutron and gamma radiations are presented. Pure water in a reactor system minimizes radioactivity during operations and during process-equipment maintenance. Diminished corrosion rates and scaling, as well as optimum heat-transfer rates, are effected by means of pH and dissolved-solids control. The absence of ionized solids in the water makes water decomposition practically nil. Without dissolved neutron absorbers in the water, reactor reactivity is kept high. Good water quality can be maintained by a single water pass, a percentile purge and make-up, or a by-pass purification system. For design considerations the latter cleanup flow rate is based on the experimentally verified formula $m = m_0 e^{-kft/v}$. Accepted practice provides a mixed resin bed or strong cation and anion resins with life expectancies of about one year. The resins are purchased in generated form from the manufacturer. For $D_2O$ systems a simple displacement of the $H_2O$ from the resin by means of a deuterization technique is required. Filters are used at each end of the resin beds to ensure removal of insoluble particles. Application of these methods to the Argonne (CP-3) heavy water reactors and experimental reactor loops has been successful. Similar purification bypasses are planned for the Materials Testing Reactor (MTR), Argonne Research Reactor (CP-5), the Oak Ridge National Laboratory Research Reactor, and CP-10. High-purity water creates a low background, and detection of slug-rupture products is sensitized. (auth)

**17346** TID-2503(Del.)(p.121-37)
Atomic Electric Project, St. Louis.
MONSANTO CHEMICAL COMPANY—UNION ELECTRIC COMPANY PLUTONIUM-POWER REACTOR FEASIBILITY STUDY. Kenneth A. Hub, C. Rogers McCullough, Estel M. Mabuce, Leo Arthur Ohlinger, and Milton Welhoelter. p.121-37 [of] NUCLEAR SCIENCE AND TECHNOLOGY. (EXTRACTS FROM REACTOR SCIENCE AND TECHNOLOGY. VOL. 2, ISSUES 1 TO 4, APRIL–DECEMBER 1952). 17p.

This article is a condensation of AEP-37(Pt. 1).

A study of reactors for the production of plutonium and power indicates that a sodium-cooled metallic-uranium graphite-moderated reactor appears to be the most feasible combination on which design might be started in the near future. Two preliminary conceptual designs are presented. Internal cooling of tubular fuel elements permits higher specific power outputs than externally cooled rods for a given enrichment. Internal and external cooling gives still greater specific power but requires higher enrichment. Sodium bonding between uranium and stainless steel cans is used. The maximum uranium temperatures were limited to 1100°F. It is planned to reload the reactor while in operation to increase the availability of power. Enriched fuel is required in all cases. The following sodium temperatures optimize plutonium production: inlet temperatures of 300°F and outlet temperatures of 650°F for internal cooling, and inlet temperatures of 300°F and outlet temperatures of 900°F for internal and external cooling. Based on a five-year amortization of reactor and power plant combined, electrical power is roughly competitive with power from coal-burning plants. The problem of operating the power plant in the event that plutonium is not needed is considered. Research and development problems requiring solution are outlined. Although further optimization of reactor design is required to give minimum power and plutonium costs, this will not affect the over-all feasibility. Table 1 summarizes the characteristics of the reactors described in this article. (auth)

**17347** TID-2503(Del.)(p.139-80)
Commonwealth Edison Co., Chicago.
COMMONWEALTH EDISON COMPANY—PUBLIC SERVICE COMPANY REPORT ON POWER GENERATION USING NUCLEAR ENERGY. Lester A. Evers and William M. Kiefer. p.139-80 [of] NUCLEAR SCIENCE AND TECHNOLOGY. (EXTRACTS FROM REACTOR SCIENCE AND TECHNOLOGY. VOL. 2, ISSUES 1 TO 4, APRIL–DECEMBER 1952). 42p.

This article is a condensation of CEPS-1101.

Two conceptual natural-U reactor designs are offered: a 350-Mwh, 45-Mwe, helium-cooled, graphite-moderated; and a 1064-Mwh, 211.5-Mwe, $D_2O$-moderated and $D_2O$ cooled. The total estimated costs are 40 and 118 million dollars, respectively. (T.R.H.)

**17348** TID-2503(Del.)(p.181-98)
Pacific Gas and Electric Co., San Francisco and Bechtel Corp., San Francisco.
PACIFIC GAS AND ELECTRIC COMPANY—BECHTEL CORPORATION INDUSTRIAL-REACTOR STUDY. p.181-98 [of] NUCLEAR SCIENCE AND TECHNOLOGY. (EXTRACTS FROM REACTOR SCIENCE AND TECHNOLOGY. VOL. 2, ISSUES 1 TO 4, APRIL–DECEMBER 1952). 18p.

This article is a condensation of BP-1.

Several reactors for the production of plutonium and power are reviewed. A water-cooled thermal conversion reactor utilizing natural-uranium fuel rods is proposed. This reactor would be cooled by the flow of ordinary water at high pressure, and steam would be produced by passing this heated water through a steam generator. The fuel rods would be surrounded by a heavy-water moderator. A liquid-metal-cooled fast reactor utilizing enriched-uranium fuel rods is also proposed. It would be cooled by a liquid-metal stream, which in turn would give up its heat to form steam in a steam generator. It would resemble in some respects the Experimental Breeder Reactor. Other types of power reactors considered include a liquid-metal-cooled thermal reactor with a graphite moderator, an aqueous homogeneous thermal reactor, and a liquid-fuel breeder reactor. Economic considerations on all these reactors are discussed. (auth)

**17349** TID-2503(Del.)(p.199-208)
Dow Chemical Co., Midland, Mich. and Detroit Edison Co., Detroit.
DOW CHEMICAL COMPANY—DETROIT EDISON COMPANY STUDY OF MATERIALS- AND POWER-PRODUCING REACTORS. p.199-208 [of] NUCLEAR SCIENCE AND TECHNOLOGY. (EXTRACTS FROM REACTOR SCIENCE AND TECHNOLOGY. VOL. 2, ISSUES 1 TO 4, APRIL–DECEMBER 1952). 10p.

This article is a condensed and deleted version of TID-5093.

From The Dow Chemical Co.–Detroit Edison Company study of nuclear power, it was concluded that there is an important potential in atomic energy, even though it cannot yet be demonstrated that reactors will be economical for power production alone. It is believed that, if nuclear energy is to be made competitive with the energy sources presently used, the following seven specifications must be met in a power reactor: 1. The reactor should utilize low-cost fuel, i.e., it should be a breeder reactor which within itself converts thorium or depleted uranium to fissionable material for fuel. 2. The reactor should have a high breeding gain, i.e., be a fast-neutron reactor. 3. The reactor should be a high-temperature machine if it is to produce power as well as fissionable materials. 4. The reactor should be capable of integration with a liquid-metal-phase extraction process, permitting fast low-cost recovery of fissionable materials and fission products. 5. The reactor should require a minimum exclusion area. 6. The reactor should use uncanned fuel, preferably "mobile" or fluid fuel. 7. The reactor should be inherently self-regulating. It seems probable that these specifications can be substantially met utilizing materials, processes, and designs which now exist in partially developed form or which offer promise for satisfactory development within a reasonable period of time. (auth)

**17350** TID-2503(Del.)(p.209-34)
Argonne National Lab., Lemont, Ill.
THE ARGONNE FLUORIDE-VOLATILITY PROCESS FOR THE SEPARATION OF URANIUM. Herbert H. Hyman and Joseph J. Katz. p.209-34 [of] NUCLEAR SCIENCE AND TECHNOLOGY. (EXTRACTS FROM REACTOR SCIENCE AND TECHNOLOGY. VOL. 2, ISSUES 1 TO 4, APRIL–DECEMBER 1952.) 26p. (ANL-WMM-1013(Rev.)(Del.2)).

This article is taken from ANL-4709.

The Argonne fluoride-volatility process is described. Conversion of irradiated uranium to uranium hexafluoride by liquid-phase fluorination with bromine trifluoride solution is discussed in some detail. The chemistry of the halogen fluorides is discussed briefly, and the behavior of uranium, plutonium, and fission products in these systems is described. A flow sheet is outlined for the utilization of these properties to meet process requirements. The potential utility of the volatility procedure in a variety of applications is pointed out. (auth)

**17351** TID-2503(Del.)(p.235-48)
Oak Ridge National Lab., Tenn.
RECOVERY OF ENRICHED URANIUM FROM IRRADIATED REACTOR FUELS BY SOLVENT EXTRACTION. W. B. Lanham. p.235-48 [of] NUCLEAR SCIENCE AND TECHNOLOGY. (EXTRACTS FROM REACTOR SCIENCE AND TECHNOLOGY. VOL. 2, ISSUES 1 TO 4, APRIL–DECEMBER 1952). 14p. (CF-52-8-179(Rev.)(Del. 2)).

The need for recovering unconsumed enriched uranium from the fuel assemblies of the Materials Testing Reactor led to the development of a solvent-extraction process for this purpose. However, with a few minor changes this chemical process may be used for the recovery of uranium from any aluminum-clad fuel element of uranium or uranium-aluminum alloy. The chemical flow sheets presented are those to be used at the Idaho Falls plant (National Reactor Testing Station) for the processing of enriched uranium slugs and the fuel elements from the Materials Testing and Experimental Breeder reactors. The recovery of uranium and its separation from fission products and other impurities are accomplished by continuous solvent extraction using methyl isobutyl ketone as the solvent. The effect of the more important variables is discussed, and a summary of the results of pilot-plant verification runs is given. (auth)

**17352** TID-2503(Del.)(p.249-72)
RAND Corp., Santa Monica, Calif.
NOTES ON MULTI-GROUP TECHNIQUES FOR THE INVESTIGATION OF NEUTRON DIFFUSION. George Safonov. p.249-72 [of] NUCLEAR SCIENCE AND TECHNOLOGY. (EXTRACTS FROM REACTOR SCIENCE AND TECHNOLOGY. VOL. 2, ISSUES 1 TO 4, APRIL–DECEMBER 1952). 23p. (R-233(RAND)).

Multi-group equations are derived for the analysis of neutron diffusion in general and for the study of reactor criticality in particular. In contrast to the multi-group equations obtained from the Fermi age equation, the equations presented here are constructed from the Boltzmann equation used in conjunction with the diffusion approximation and from the Boltzmann equation used in conjunction with an integral relating neutron flux and current. Prescriptions are listed for energy transfer coefficients associated with hydrogenous and nonhydrogenous moderators and with moderation by inelastic collision. A sample analysis considers a series of reactors containing the three ingredients $U^{235}$, $U^{238}$, and C. The "buckling," the critical mass of $U^{235}$, and the ratio of the rate of radiative capture in $U^{238}$ to the absorption rate in $U^{235}$ are given as functions of the mixture. Multi-group and age analyses are compared and shown to be in good agreement for all but very weakly moderating mixtures. The pure $U^{235}$ sphere is investigated by use of the multi-group equations derived

according to the procedure stated above. The critical radius is found to agree to within 1 per cent with that obtained using spherical harmonics with a $P_5$ approximation. An appendix outlines a method for the fundamental mode analysis of bare reactors by the use of the multi-group equations. (auth)

**17353** TID-2503(Del.)(p.273-80)
Argonne National Lab., Lemont, Ill.
THE $P_3$ APPROXIMATION TO THE TRANSPORT EQUATION FOR CYLINDRICAL GEOMETRY. Richard R. Haefner. p.273-80 [of] NUCLEAR SCIENCE AND TECHNOLOGY. (EXTRACTS FROM REACTOR SCIENCE AND TECHNOLOGY. VOL. 2, ISSUES 1 TO 4, APRIL–DECEMBER 1952). 8p. (ANL-MH-66(Del.)).

The $P_3$ spherical harmonic approximation to the transport equation has been developed for cylindrical geometry. Equations for the flux components are given. The theoretical flux plots are compared with experimental data. The neutron vector flux at various positions in the cell is shown in three orthogonal planes. A comparison is also made of the $P_3$ approximation and simple diffusion theory. (auth)

**17354** TID-2503(Del.)(p.281-97)
North American Aviation, Inc., Downey, Calif.
URANIUM-BEARING-GRAPHITE FUEL ELEMENTS. Frank E. Faris. p.281-97 [of] NUCLEAR SCIENCE AND TECHNOLOGY. (EXTRACTS FROM REACTOR SCIENCE AND TECHNOLOGY. VOL. 2, ISSUES 1 TO 4, APRIL–DECEMBER 1952). 17p. (NAA-SR-191 (Rev.)(Del. 2)).

Homogeneous uranium-bearing-graphite fuel elements are discussed from the following standpoints: preparation of the elements, chemical processing, properties, radiation damage, and applications. Information now available is reviewed, and questions on which further information is needed are indicated. (auth)

**17355** TID-2503(Del.)(p.299-331)
Phillips Petroleum Co. Atomic Energy Div., Idaho Falls, Idaho.
THE MATERIALS TESTING REACTOR DESIGN. John R. Huffman. p.299-331 [of] NUCLEAR SCIENCE AND TECHNOLOGY. (EXTRACTS FROM REACTOR SCIENCE AND TECHNOLOGY. VOL. 2, ISSUES 1 TO 4, APRIL–DECEMBER 1952.) 32p.

The Materials Testing Reactor, which has been under design and construction since 1945, is now in operation at the National Reactor Testing Station near Idaho Falls, Idaho. It is an enriched reactor, reflected with beryllium, and is the first reactor using the thin-plate fuel-assembly construction. It operates at the highest thermal flux of any known reactor and has one of the highest heat fluxes and specific powers yet investigated. Experiments which will use many of the approximately one hundred available locations are already being inserted or are in the final stages of design. (auth)

**17356** TID-2503(Del.)(p.333-6)
North American Aviation, Inc., Downey, Calif.
A TABLE MODEL REACTOR. A. T. Biehl, D. L. Hetrick, and G. A. Bennett. p.333-6 [of] NUCLEAR SCIENCE AND TECHNOLOGY. (EXTRACTS FROM REACTOR SCIENCE AND TECHNOLOGY. VOL. 2, ISSUES 1 TO 4, APRIL–DECEMBER 1952.) 4p. (NAA-SR-Memo-352).

The design of a proposed 100-milliwatt $25,000 research and training reactor having as fuel a homogeneous mixture of enriched uranium oxide in a solid hydrocarbon is discussed. The reactor would have an over-all diameter of less than 6 ft and would not require special buildings or facilities other than those normally found in research laboratories. (auth)

**17357** TID-2503(Del.)(p.337-44)
Argonne National Lab., Lemont, Ill.
A $U^{233}$ BREEDER–$U^{235}$ CONVERTER REACTOR. B. I. Spinrad and Leonard I. Katzin. p.337-44 [of] NUCLEAR SCIENCE AND TECHNOLOGY. (EXTRACTS FROM REACTOR SCIENCE AND TECHNOLOGY. VOL. 2, ISSUES 1 TO 4, APRIL–DECEMBER 1952). 8p. (ANL-MH-58).

A description of a fluid-fuel-fluid-absorber thermal reactor for the production of $U^{233}$ is presented, and the conditions for maximum efficiency as a breeder (shortest doubling time) are elaborated. With very little modification of operating conditions and no modifications in the structure, the machine shows promise as an efficient $U^{235}$-$U^{233}$ converter, with the possibility also of by-product power. Some of the development work required is indicated. In particular, achievement of high pumping rates for maximum heat transfer and fabrication of very thin-walled zirconium tubing pay large dividends. (auth)

**17358** TID-2503(Del.)(p.381-4)
Bettelle Memorial Inst., Columbus, Ohio.
HIGH-SPEED PHOTOGRAPHY IN REACTOR MECHANISM DEVELOPMENT. P. F. Forgrave, G. A. Waldie, and R. M. Conklin. p.381-4 [of] NUCLEAR SCIENCE AND TECHNOLOGY. (EXTRACTS FROM REACTOR SCIENCE AND TECHNOLOGY. VOL. 2, ISSUES 1 TO 4, APRIL–DECEMBER 1952.) 4p. (TID-5072(Del.)).

The use of a 3000 frame per second camera to study the action of a reactor scram-latch system is described. The method eliminated the necessity for application of transducers to the system, and can be extended to the study of mechanisms operating in high pressure water at high temperatures. (T.R.H.)

**17359** TID-2503(Del.)(p.385-7)
Oak Ridge National Lab., Tenn.
THERMAL-NEUTRON CAPTURE CROSS SECTIONS OF URANIUM. H. Pomerance. p.385-7 [of] NUCLEAR SCIENCE AND TECHNOLOGY. (EXTRACTS FROM REACTOR SCIENCE AND TECHNOLOGY. VOL. 2, ISSUES 1 TO 4, APRIL–DECEMBER 1952.) 3p. (CF-51-12-151).

The thermal neutron capture cross sections for $U^{234}$, $U^{236}$, and $U^{238}$ were measured in the Oak Ridge National Laboratory reactor oscillator. The following values are reported: $U^{234}$–88 barns ±7%; $U^{236}$–5.8 barns ±30%; $U^{238}$ (avg.)–2.81 barns ±3%. (T.R.H.)

**17360** TID-2503(Del.)(p.389-91)
Iowa State Coll., Ames.
PREPARATION OF STABLE BINARY URANIUM OXIDE SLURRIES. Robert S. Hansen, Robert E. Minturn, and Bert H. Clampitt. p.389-91 [of] NUCLEAR SCIENCE AND TECHNOLOGY. (EXTRACTS FROM REACTOR SCIENCE AND TECHNOLOGY. VOL. 2, ISSUES 1 TO 4, APRIL–DECEMBER 1952.) 3p. (ISC-194).

A series of binary uranium oxide slurries (containing no stabilizing agent) have been prepared. Of the slurries prepared, seven were of moderate to excellent stability at 25°C, and of these, four were of moderate to good stability at 250°C. Uranium oxides successfully slurried in water were $UO_2$, $U_3O_8$, $UO_4 \cdot 4H_2O$, and $UO_3$. (auth)

**17361** TID-2503(Del.)(p.393-9)
National Bureau of Standards, Washington, D. C.
THE URANIUM–TITANIUM BINARY SYSTEM. R. W. Buzzard, R. B. Liss, and D. P. Fickle. p.393-9 [of] NUCLEAR SCIENCE AND TECHNOLOGY. (EXTRACTS

FROM REACTOR SCIENCE AND TECHNOLOGY. VOL. 2, ISSUES 1 TO 4, APRIL–DECEMBER 1952.) 7p. (NBS-D-112).

The uranium-titanium system within the range of 0 to 30 at. % titanium was developed by thermal, metallographic, and x-ray analysis. The liquidus rises from the melting point of uranium at 1130°C to a peritectic at 1180°C and 2.6 at. % titanium, rising sharply to 1925°C at 30 at. % titanium. The peritectic terminates in a sharply rising solidus at approximately 15.4 at. % titanium. The system is characterized by two solid solution (gamma and delta) phases which decompose eutectoidally. The gamma solid solution has a solubility of 8.8 at. % titanium at 1180°C and decomposes eutectoidally at 718°C, the eutectoid composition being 5 at. % titanium. The delta solid solution decomposes eutectoidally at 830°C, having a eutectoid composition of 18.3 at. % titanium. The delta solid solution appears to be the high melting phase rather than the compound (epsilon) as previously reported. The compound apparently forms peritectically; it appeared in the extreme titanium end of the alloy range covered by this investigation. (auth)

**17362** TID-2503(Del.)(p.401-13)
National Bureau of Standards, Washington, D. C.
THE URANIUM–BERYLLIUM BINARY SYSTEM. Robert W. Buzzard, James T. Sterling, Ellen A. Buzzard, and John H. Darr. p.401-13 [of] NUCLEAR SCIENCE AND TECHNOLOGY. (EXTRACTS FROM REACTOR SCIENCE AND TECHNOLOGY. VOL. 2, ISSUES 1 TO 4, APRIL–DECEMBER 1952.) 13p. (NBS-D-113.)

The constitution diagram was developed by thermal analysis, metallographic examination, and x-ray diffraction. The uncertain features, in conformation with accepted convention, are depicted by dotted lines. One compound, $UBe_{13}$, occurs in the system. $UBe_{13}$ is a stable phase having a face-centered cubic structure and a melting point of approximately 2000°C. A eutectic occurs at 1090°C between uranium and $UBe_{13}$, having a composition of less than 0.2 wt. % beryllium. The liquidus rises sharply from the eutectic to about 1800°C, reaching the maximum at the melting point of the compound. A monotectic occurs at 1555°C and 60 wt. % beryllium. The liquidus falls sharply at 80 wt. % beryllium to an almost flat liquidus between 90 and 100 wt. % beryllium. The solubility of beryllium in uranium is small, and the solubility of uranium in beryllium is undetectable. The transformation temperatures of uranium were unaffected. (auth)

**17363** TID-2503(Del.)(p.415-22)
National Bureau of Standards, Washington, D. C.
THE URANIUM–ZIRCONIUM BINARY SYSTEM. Robert W. Buzzard, R. B. Liss, and D. P. Fickle. p.415-22 [of] NUCLEAR SCIENCE AND TECHNOLOGY. (EXTRACTS FROM REACTOR SCIENCE AND TECHNOLOGY. VOL. 2, ISSUES 1 TO 4, APRIL–DECEMBER 1952.) 8p. (NBS-D-116).

The phase diagram for the uranium-zirconium system within the range 0 to 43 at. % zirconium was developed by thermal, metallographic, and x-ray techniques. The solubility of zirconium in alpha uranium was low, being approximately 2 at. % at room temperature and rising to 6 at. % at 685°C. The beta-gamma transition was lowered to 685°C at 18.5 at. %. Two horizontals were observed in the system, one at 685°C and the other at 610°C. Above 685°C a continuous solid solution between beta-zirconium and uranium existed. (auth)

**17364** TID-2503(Del.)(p.423-31)
North American Aviation, Inc., Downey, Calif.
EFFECT ON REACTOR PERFORMANCE OF ALLOYING ELEMENTS AND METALLIC BONDS. E. F. Weisner. p.423-31 [of] NUCLEAR SCIENCE AND TECHNOLOGY. (EXTRACTS FROM REACTOR SCIENCE AND TECHNOLOGY. VOL. 2, ISSUES 1 TO 4, APRIL–DECEMBER 1952). 9p. (NAA-SR-Memo-331).

A method is presented for making rapid estimates of the multiplication constants $k_\infty$ of heterogeneous reactors with internally cooled cylindrical slugs. The actual system is approximated by a simpler one-group two-region problem having the same moderator-to-uranium flux ratio, from which f and p may be computed. Graphs of the fast fission factor $\epsilon$ for hollow cylinders are obtained from the more general treatment. (auth)

**17365** TID-2503(Del.)(p.433-7)
North Carolina State Coll., Raleigh.
MULTIPLICATION CONSTANTS FOR HETEROGENEOUS REACTORS WITH INTERNALLY COOLED SLUGS BY AN APPROXIMATE METHOD. R. L. Murray and A. C. Menius, Jr. p.433-7 [of] NUCLEAR SCIENCE AND TECHNOLOGY. (EXTRACTS FROM REACTOR SCIENCE AND TECHNOLOGY. VOL. 2, ISSUES 1 TO 4, APRIL–DECEMBER 1952). 5p. (NCSC-52).

The use of small amounts of alloying elements and thin layers of bonding materials may be given serious consideration for use in reactors employing uranium metal fuel. The effect on plutonium production which results from the use of alloyed or bonded fuel is small, provided that the alloying or bonding is accomplished with small amounts of low-cross-section elements. In general, the effect on conversion ratio and plutonium production is much less for reactors which use slightly enriched fuel than for reactors which use natural-uranium fuel. These conclusions hold for any practical, realizable fractional burn-up of the fuel, since this quantity was not a factor in the discussion. (auth)

**17366** TID-2503(Del.)(p.439-42)
Oak Ridge National Lab., Tenn.
PRELIMINARY BOILING EXPERIMENT IN THE LITR. W. M. Breazeale, T. E. Cole, and J. A. Cox. p.439-42 [of] NUCLEAR SCIENCE AND TECHNOLOGY. (EXTRACTS FROM REACTOR SCIENCE AND TECHNOLOGY. VOL. 2, ISSUES 1 TO 4, APRIL–DECEMBER 1952.) 4p. (TID-5065).

Experiments with the Low Intensity Training Reactor are described in which the period safety was disconnected and an oscillograph was connected across the servo chamber of the servo automatic control. Fuel plate temperature was recorded. It was shown that boiling starts at a reasonable power level and oscillations build up at a stable value. (T.R.H.)

**17367** TID-2503(Del.)(p.443-6)
Argonne National Lab., Lemont, Ill.
APPLICATION OF MAGNESIUM TO REACTOR DESIGN. Samuel Untermyer. p.443-6 [of] NUCLEAR SCIENCE AND TECHNOLOGY. (EXTRACTS FROM REACTOR SCIENCE AND TECHNOLOGY. VOL. 2, ISSUES 1 TO 4, APRIL–DECEMBER 1952). 4p. (ANL-WPB-335).

The properties of magnesium are reviewed and its uses in fuel elements and in the structure of air-cooled reactors are discussed. (T.R.H.)

**17368** TID-2503(Del.)(p.447-52)
Oak Ridge National Lab., Tenn.
FURTHER BOILING EXPERIMENTS IN THE LITR. W. M. Breazeale, T. E. Cole, and J. A. Cox. p.447-52 [of] NUCLEAR SCIENCE AND TECHNOLOGY. (EXTRACTS FROM REACTOR SCIENCE AND TECHNOLOGY. VOL. 2, ISSUES 1 TO 4, APRIL–DECEMBER 1952). 6p.

Measurements were made of the relation of boiling rate and change in reactivity. A Brush oscillograph recorded neutron flux transients. The study shows that this solid fuel reactor is safe from runaway if left on a rising period. While boiling, it is in a stable oscillating condition. Care must be used in transferring these results to the design of boiling reactors. (T.R.H.)

**17369** TID-2503(Del.)(p.453-5)
Brookhaven National Lab., Upton, N. Y.
NEUTRON CROSS SECTIONS. p.453-5 [of] NUCLEAR SCIENCE AND TECHNOLOGY. (EXTRACTS FROM REACTOR SCIENCE AND TECHNOLOGY. VOL. 2, ISSUES 1 TO 4, APRIL–DECEMBER 1952). 3p.

Thermal neutron cross sections are given for $C^{12}$, $Ac^{227}$, $Th^{232}$, $U^{233}$, $U^{234}$, $U^{235}$, $U^{236}$, $Pu^{239}$, $Pu^{240}$, $Pu^{241}$, and $Pu^{242}$ to correct and supplement data reported previously. Other supplementary comments on neutron cross section data are included. (T.R.H.)

**17370** TID-2504(Del.)
Technical Information Service Extension, AEC.
NUCLEAR SCIENCE AND TECHNOLOGY. (EXTRACTS FROM REACTOR SCIENCE AND TECHNOLOGY. VOL. 3, ISSUES 1 TO 4, MARCH–DECEMBER 1953). Decl. with deletions Feb. 26, 1957. 312p. $48.60(ph OTS); $11.10(mf OTS).

About thirty articles are included in this issue. Separate abstracts have been prepared for each. (T.R.H.)

**17371** TID-2504(Del.)(p.15-21)
Knolls Atomic Power Lab., Schenectady, N. Y.
A STUDY OF THE RADIATION STABILITY OF AUSTENITIC TYPE 347 STAINLESS STEEL. M. B. Reynolds, J. R. Low, Jr., and L. O. Sullivan. p.15-21 [of] NUCLEAR SCIENCE AND TECHNOLOGY. (EXTRACTS FROM REACTOR SCIENCE AND TECHNOLOGY. VOL. 3, ISSUES 1 TO 4, MARCH–DECEMBER 1953). 7p.

The effect of neutron bombardment upon the stability of type 347 austenitic stainless steel has been investigated by a magnetic technique. The relation of the ferrite content of a stainless steel to its magnetic properties is given, and an apparatus suitable for the measurement of the ferromagnetic saturation induction of small specimens is described. Results of measurements on irradiated specimens are tabulated. Exposure to a neutron flux was found to cause a slight increase in the ferrite content the change increasing with increasing length of exposure and with increasing initial ferrite content. The similarity between the effect of irradiation and the effect of annealing is pointed out. The possible effect of irradiation upon the density of austenitic S.S. is discussed. (auth)

**17372** TID-2504(Del.)(p.23-42)
Oak Ridge National Lab., Tenn.
THE RADIATION CHEMISTRY OF AQUEOUS REACTOR SOLUTIONS. PART I. RADIATION-INDUCED DECOMPOSITION. J. E. Boyle, J. A. Ghormley, C. J. Hochanadel, W. F. Kieffer, and T. J. Sworski. p.23-42 [of] NUCLEAR SCIENCE AND TECHNOLOGY. (EXTRACTS FROM REACTOR SCIENCE AND TECHNOLOGY. VOL. 3, ISSUES 1 TO 4, MARCH–DECEMBER 1953.) 19p.

The decomposition of reactor-irradiated aqueous U solutions has been studied as a function of U concentration, isotopic enrichment, temperature, anion accompanying the U, oxidation state of U, pH, and added solutes. Except for the nitrate, no net change of the solute itself was observed, and the net effect was that of water decomposition to $H_2$, $O_2$, and peroxide. The initial yield of H decreased on lowering the ratio of fission-recoil energy to total energy and decreased on increasing the U concentration or the H-ion concentration. The yield was independent of temperature, anion, oxidation state of U, and the presence of some added solutes. From results reported here, the yield of H in the decomposition of water by fission-recoil particles alone was calculated to be 1.8 $H_2$ molecules per 100 ev. (auth)

**17373** TID-2504(Del.)(p.43-62)
Oak Ridge National Lab., Tenn.
THE RADIATION CHEMISTRY OF AQUEOUS REACTOR SOLUTIONS. PART 2. THE DECOMPOSITION OF PEROXIDE IN AQUEOUS HOMOGENEOUS-REACTOR SYSTEMS. M. D. Silverman, George M. Watson, and H. F. McDuffie. p.43-62 [of] NUCLEAR SCIENCE AND TECHNOLOGY. (EXTRACTS FROM REACTOR SCIENCE AND TECHNOLOGY. VOL. 3, ISSUES 1 TO 4, MARCH–DECEMBER 1953.) 20p.

The decomposition of $H_2O_2$ in $UO_2SO_4$ solutions has been found to be first order in $H_2O_2$ and independent of the U concentration. The rate also appears to be independent of the acidity of the solution. First order specific reaction rate constants have been determined at 53, 78, and 100°C. A conductance method has been developed for following the decomposition at rates which preclude successful use of the chemical method employed for early work on this problem. The conductance method, which agrees with the chemical method to within 5%, has been used to investigate catalytic effects from possible corrosion and fission product species in $UO_2SO_4$ solutions. Allowable homogeneous reactor operating levels have been estimated from the data. (auth)

**17374** TID-2504(Del.)(p.63-8)
Brookhaven National Lab., Upton, N. Y.
RECENT ADVANCES IN NEUTRON MEASUREMENTS IN THE INTERMEDIATE-ENERGY REGION. D. J. Hughes. p.63-8 [of] NUCLEAR SCIENCE AND TECHNOLOGY. (EXTRACTS FROM REACTOR SCIENCE AND TECHNOLOGY. VOL. 3, ISSUES 1 TO 4, MARCH–DECEMBER 1953.) 6p.

One of the main concerns of the AEC Neutron Cross Section Advisory Group during the last two years has been the need for work of high resolution in the energy region from 10 ev to 10 kev. This region is approached from below by velocity selectors and monochromators and from above by Van de Graaff accelerators. The efforts of workers at various laboratories, both in the United States and abroad, however, have now resulted in a complete bridging of this energy gap with at least fair resolutions. Several types of velocity selectors have been instrumental in closing the gap; they are described briefly in this report. The most recent velocity selector to be put in operation, the Brookhaven National Laboratory fast chopper, is treated in some detail. (auth)

**17375** TID-2504(Del.)(p.69-79)
Oak Ridge National Lab., Tenn.
SOME ASPECTS OF REACTOR THEORY. Alvin M. Weinberg. p.69-79 [of] NUCLEAR SCIENCE AND TECHNOLOGY. (EXTRACTS FROM REACTOR SCIENCE AND TECHNOLOGY. VOL. 3, ISSUES 1 TO 4, MARCH–DECEMBER 1953.) 11p.

A comparison is drawn between the theory of small homogeneous reactors, in which the asymptotic flux distribution derived from the appropriate Boltzmann equation is of major importance, and the theory of more complicated reactors in which the nonasymptotic solutions are overwhelming, requiring multigroup methods and International Business Machines equipment or the like. Three unsolved problems in reactor theory are

discussed, namely, how to compute the spatial details of the power distribution in a system in which irregular shim-rod positions cause serious local peaks, how to estimate the turbulent fluctuations caused by bubbling, temperature variations, or concentration variations in a high-powered boiling or homogeneous reactor, and how to compute the diffusion length in a multiplying lattice. Finally, the importance of critical-mass computation is stressed both as a method not satisfactorily replaced by critical experiments and as a means of furthering and strengthening reactor theory in general. (T.R.H.)

**17376** TID-2504(Del.)(p.81-107)
Knolls Atomic Power Lab., Schenectady, N. Y.
MULTIGROUP METHODS. H. Hurwitz, Jr. and R. Ehrlich. p.81-107 [of] NUCLEAR SCIENCE AND TECHNOLOGY. (EXTRACTS FROM REACTOR SCIENCE AND TECHNOLOGY. VOL. 3, ISSUES 1 TO 4, MARCH–DECEMBER 1953.) 27p.

The age-diffusion equation is adequate to describe the neutron behavior of a very large class of nonthermal reactors (all except those whose dimensions are comparable to the neutron mean free path). Thus, a convenient means of obtaining an accurate solution to this equation is very useful for general reactor calculations. Methods for reducing the age-diffusion equation to a finite set of coupled ordinary differential equations, called multigroup equations, are described. The relative merits of several alternate schemes are discussed. The multigroup equations may be solved by iterative procedures based on an assumed spatial distribution of the fission-source neutrons. In practice, the initially assumed source shape is accurate enough so that additional iterations are unnecessary. Analytical and numerical methods for solving the multigroup equations with the assumed source are discussed. The adjoint equations are also reduced to multigroup form, and examples of the use of the adjoint function in obtaining improved reactivity values are given. (auth)

**17377** TID-2504(Del.)(p.109-39)
North American Aviation, Inc., Downey, Calif.
CONSIDERATIONS AFFECTING THE UTILITY AND SAFETY CHARACTERISTICS OF LOW-POWER RESEARCH REACTORS. Joachim B. Ehrman. p.109-39 [of] NUCLEAR SCIENCE AND TECHNOLOGY. (EXTRACTS FROM REACTOR SCIENCE AND TECHNOLOGY. VOL. 3, ISSUES 1 TO 4, MARCH–DECEMBER 1953). 31p. (NAA-SR-Memo-435(Rev. 2)(Del.)).

Safety and utility criteria of low-power research reactors (10 to 100 kw) as typified by the Los Alamos Water Boiler, the Bulk Shielding Facility, and the NAA Low Power Research Reactor are reviewed. Two-group reactivity and criticality calculations are carried out for each of these reactors. Comparison data are presented for neutron fluxes and general experimental facilities available in each case. (T.R.H.)

**17378** TID-2504(Del.)(p.141-55)
Brookhaven National Lab., Upton, N. Y.
EXPONENTIAL EXPERIMENTS ON LIGHT-WATER-MODERATED ONE PER CENT $U^{235}$ LATTICES. H. J. Kouts, Kenneth W. Downes, Rudolph Sher, Glenn A. Price, and Valentine J. Walsh. p.141-55 [of] NUCLEAR SCIENCE AND TECHNOLOGY. (EXTRACTS FROM REACTOR SCIENCE AND TECHNOLOGY. VOL. 3, ISSUES 1 TO 4, MARCH–DECEMBER 1953). 15p. (BNL-1358(Del.)).

Exponential experiments are being carried out on light-water-moderated lattices of slightly enriched uranium. Included are measurements of buckling, degree of anisotropy of the migration area, and cadmium ratios for aluminum-clad 0.750-in.-diameter rods of 1 per cent $U^{235}$, with a ratio of water and aluminum to uranium metal ranging from 1.5 to 1 to 4 to 1. The methods of measurement are presented, and the experimental uncertainties are discussed. (auth)

**17379** TID-2504(Del.)(p.157-73)
California Research and Development Co. Livermore Research Lab., Livermore, Calif.
THE CHELATE PROCESS. H. W. Crandall and T. E. Hicks. p.157-73 [of] NUCLEAR SCIENCE AND TECHNOLOGY. (EXTRACTS FROM REACTOR SCIENCE AND TECHNOLOGY. VOL. 3, ISSUES 1 TO 4, MARCH–DECEMBER 1953.) 17p. (LWS-24702(Del.)).

The Chelate process was conceived to promote the recovery and purification of plutonium from dilute aqueous solutions of irradiated-uranium fuels by solvent extraction with thenoyltrifluoroacetone (TTA) in an organic diluent. The basic chemistry, kinetics, extraction mechanisms, and experimental data of the systems studied are reviewed. The experimental stability constants for a large number of metallic chelates of TTA are presented as an indication of the extreme selectivity of such a solvent-extraction system. Solubilities of the metallic chelates in various diluent-TTA homologue combinations, flow sheets for batch- and continuous-flow schemes, and types of contacting equipment and engineering problems involved are discussed. (auth)

**17380** TID-2504(Del.)(p.175-99)
Phillips Petroleum Co. Atomic Energy Div., Idaho Falls, Idaho.
START-UP OF THE MATERIALS TESTING REACTOR. John R. Huffman, D. R. deBoisblanc, and W. E. Nyer. p.175-99 [of] NUCLEAR SCIENCE AND TECHNOLOGY. (EXTRACTS FROM REACTOR SCIENCE AND TECHNOLOGY. VOL. 3, ISSUES 1 TO 4, MARCH–DECEMBER 1953.) 25p. (IDO-16028).

When the construction of the Materials Testing Reactor was completed in March 1952, a series of experiments was initiated to investigate the behavior of the reactor and its potentialities as an irradiation facility. These tests covered studies of critical mass, flux distribution, sensitivity of control rods, temperature coefficient, available excess reactivity, statistical-weight factors, poison effects, and operation at full power. This article presents data obtained from these experiments in graphical and tabular form and discusses briefly their effect on the operation of the Materials Testing Reactor. (auth)

**17381** TID-2504(Del.)(p.221-38)
Public Service Co. of Northern Illinois, Chicago.
A SECOND REPORT ON THE FEASIBILITY OF POWER GENERATION USING NUCLEAR ENERGY. George L. Redman. p.221-38 [of] NUCLEAR SCIENCE AND TECHNOLOGY. (EXTRACTS FROM REACTOR SCIENCE AND TECHNOLOGY. VOL. 3, ISSUES 1 TO 4, MARCH–DECEMBER 1953.) 18p.

The Commonwealth Edison–Public Service group (CEPS) completed its conceptual design of a 1243-megawatt heat, 246-megawatt net electric power light-water-moderated and -cooled reactor as the first part of its second year's study of reactors for the production of both power and plutonium. The purpose of this study was to compare the capital costs and performance of a light-water design with those of the previously reported designs of a heavy-water-moderated and -cooled reactor. The CEPS group is studying more-advanced reactor types, particularly those employing liquid-metal coolants, since this appears to be an appropriate sequel to the previous work by this group on gas- and water-

cooled reactor designs. A description of the principal nuclear, mechanical, and electrical features of the light-water reactor design is included. (auth)

**17382** TID-2504(Del.)(p.239-43)
Ames Lab., Ames, Iowa.
THE MOLTEN-METAL-FUEL REACTOR. Frank H. Spedding. p.239-43 [of] NUCLEAR SCIENCE AND TECHNOLOGY. (EXTRACTS FROM REACTOR SCIENCE AND TECHNOLOGY. VOL. 3, ISSUES 1 TO 4, MARCH–DECEMBER 1953.) 5p. (ISC-318(Del.)).

A general discussion of the history, advantages, and problems of the molten-metal-fuel reactor is given. A drawing is included showing preliminary plans for a molten-metal enriched fast reactor with molten-metal extraction of impurities and Pu. (T.R.H.)

**17383** TID-2504(Del.)(p.245-6)
Massachusetts Inst. of Tech., Cambridge.
REACTOR COOLED BY BOILING METAL. Albert R. Kaufmann and R. Schuhmann. p.245-6 [of] NUCLEAR SCIENCE AND TECHNOLOGY. (EXTRACTS FROM REACTOR SCIENCE AND TECHNOLOGY. VOL. 3, ISSUES 1 TO 4, MARCH–DECEMBER 1953.). 2p.

The possibility of cooling a liquid metal fuel alloy by boiling one metal out is discussed. (T.R.H.)

**17384** TID-2504(Del.)(p.247-9)
Massachusetts Inst. of Tech., Cambridge.
CENTRIFUGAL FLUID-FUEL REACTOR. A. R. Kaufmann. p.247-9 [of] NUCLEAR SCIENCE AND TECHNOLOGY. (EXTRACTS FROM REACTOR SCIENCE AND TECHNOLOGY. VOL. 3, ISSUES 1 TO 4, MARCH–DECEMBER 1953.) 3p.

The liquid-metal-fuel, liquid-metal-cooled reactor core design is based on the centrifugal separation, within the core, of a fuel-coolant system composed of metals of different density. A U-Al liquid-fuel alloy and a liquid-Pb coolant are suggested, with the centrifugal forces supplied by a whirling core tank. The coolant metal, denser than the fuel, is introduced in shot form, and the liquefied metal is continuously removed from the outer edge of the tank. Advantages of this system include the elimination of pumps and valves, good fuel-coolant contact, partial elimination of the container and piping problem, and continuous removal of the fuel for reprocessing. (T.R.H.)

**17385** TID-2504(Del.)(p.251-61)
Brookhaven National Lab., Upton, N. Y.
AN INTERNALLY COOLED LIQUID-METAL-FUEL REACTOR. Robert J. Teitel. p.251-61 [of] NUCLEAR SCIENCE AND TECHNOLOGY. (EXTRACTS FROM REACTOR SCIENCE AND TECHNOLOGY. VOL. 3, ISSUES 1 TO 4, MARCH–DECEMBER 1953.) 11p.

Several new features that can be applied to liquid-metal-fuel reactors are described. These are intermetallic dispersions of fuel and fertile materials; the use of the fertile streams as a core coolant; the use of graphite to contain the fuel and fertile stream; "pot type" construction; and the use of naturally occurring lead of low capture cross section. A preliminary design of a power breeder incorporating these features is given. Values for such factors as size, power, inventory, and doubling-time are calculated and appear to compare favorably with other designs. (auth)

**17386** TID-2504(Del.)(p.297-9)
Westinghouse Electric Corp. Atomic Power Div., Pittsburgh.
DIFFUSION LENGTH OF THERMAL NEUTRONS IN WATER. M. Danzker, H. L. Garabedian, and A. F. Henry. p.297-9 [of] NUCLEAR SCIENCE AND TECHNOLOGY. (EXTRACTS FROM REACTOR SCIENCE AND TECHNOLOGY. VOL. 3, ISSUES 1 TO 4, MARCH–DECEMBER 1953.) 3p. (WAPD-T-17).

Calculations on the transport mean free path and diffusion length of thermal neutrons in water are presented. Experimental results of various authors on thermal neutron diffusion length in water are summarized. (L.T.W.)

**17387** TID-2504(Del.)(p.301-9)
Bendix Aviation Corp. Research Labs., Detroit.
AN ANALYSIS OF THE STABILITY OF A STEAM-GENERATING REACTOR. Richard G. Mallon. p.301-9 [of] NUCLEAR SCIENCE AND TECHNOLOGY. (EXTRACTS FROM REACTOR SCIENCE AND TECHNOLOGY. VOL. 3, ISSUES 1 TO 4, MARCH–DECEMBER 1953.) 9p.

A stability study has been made of a reactor designed for the direct production of high-pressure steam. The time-dependent equations for heat production and removal in the steam-generating reactor have been set up. By means of an analog computer these equations were solved for initial conditions corresponding to various externally impressed disturbances. Curves representing a typical solution have been presented. (auth)

**17388** TID-2504(Del.)(p.311-13)
Brookhaven National Lab., Upton, N. Y.
NEUTRON CROSS SECTIONS. p.311-13 [of] NUCLEAR SCIENCE AND TECHNOLOGY. (EXTRACTS FROM REACTOR SCIENCE AND TECHNOLOGY. VOL. 3, ISSUES 1 TO 4, MARCH–DECEMBER 1953.) 3p.

The activities of the Neutron Cross Section Compilation Group at BNL are outlined. The experimental methods used as source material for the cross-section curves published in BNL-170 and BNL-170A are described, with new corrections to be applied in several cases. New or revised data are presented for the thermal neutron cross sections of $Xe^{135}$, $Ra^{226}$, $Ac^{227}$, $Th^{230}$, $Pa^{231}$, $Pa^{232}$, $U^{232}$, $U^{233}$, $U^{235}$, $U^{236}$, $U^{238}$, $Np^{237}$, and $Pu^{238}$. (T.R.H.)

**17389** TID-2504(Del.)(p.315-18)
Oak Ridge National Lab., Tenn.
PHILOSOPHY OF REACTOR CONTROL. W. H. Jordan. p.315-18 [of] NUCLEAR SCIENCE AND TECHNOLOGY. (EXTRACTS FROM REACTOR SCIENCE AND TECHNOLOGY. VOL. 3, ISSUES 1 TO 4, MARCH–DECEMBER 1953.) 4p. (CF-53-3-241(Del.)).

An attempt is made to codify the control philosophy which has been developed at Oak Ridge National Laboratory (ORNL); it is hoped that it will serve as a focus for arguments on the necessity or adequacy of the various elements which we have chosen to emphasize. The elements of the philosophy are grouped under five major headings: (1) limitation on the rate of increase of reactivity, (2) instrument range, (3) fail-safe circuits, (4) interlocks, and (5) cooling rate vs. neutron level. These are discussed in turn. (auth)

**17390** TID-2504(Del.)(p.319-22)
Hanford Operations Office, AEC.
A NEW CONCEPT FOR REACTOR SAFETY DEVICES. William E. Gifford. p.319-22 [of] NUCLEAR SCIENCE AND TECHNOLOGY. (EXTRACTS FROM REACTOR SCIENCE AND TECHNOLOGY. VOL. 3, ISSUES 1 TO 4, MARCH–DECEMBER 1953.). 4p. (HAN-50094(Del.)).

The use of a can of cadmium solution with blowout disks in the active zone of a reactor to counteract runaways is proposed. The can would be covered with a thin film of $U^{235}$ to offset the negative reactivity of the neutron-absorbing material. The device would offer the

advantages of low activation energy and time, simplicity, and dependability. (T.R.H.)

**17391** TID-2504(Del.)(p.323-9)
Vitro Corp. of America, New York.
CONTINUOUS COUNTERCURRENT LYOMETALLURGY OF PITCHBLENDE. Frederick Fahnoe and Robert J. Abelson. p.323-9 [of] NUCLEAR SCIENCE AND TECHNOLOGY. (EXTRACTS FROM REACTOR SCIENCE AND TECHNOLOGY. VOL. 3, ISSUES 1 TO 4, MARCH–DECEMBER 1953.) 7p. (KLX-23-109-N).

Experiments to develop a continuous countercurrent organic leaching process for recovery of U from pitchblende are described. (T.R.H.)

**17392** TID-2504(Del.)(p.331-3)
Consolidated Vultee Aircraft Corp., Fort Worth, Tex.
NOTE ON A GREEN'S FUNCTION TREATMENT OF THE TWO-GROUP METHOD. Tino Ahrens. p.331-3 [of] NUCLEAR SCIENCE AND TECHNOLOGY. (EXTRACTS FROM REACTOR SCIENCE AND TECHNOLOGY. VOL. 3, ISSUES 1 TO 4, MARCH–DECEMBER 1953). 3p.

A Green's function treatment for two-group reactor calculations is presented. (T.R.H.)

**17393** TID-2504(Del.)(p.335-6)
Knolls Atomic Power Lab., Schenectady, N. Y.
EFFECT OF FISSION ON A TWO ATOMIC PER CENT CHROMIUM–URANIUM ALLOY. Charles W. Tucker, Jr. and Peter Senio. p.335-6 [of] NUCLEAR SCIENCE AND TECHNOLOGY. (EXTRACTS FROM REACTOR SCIENCE AND TECHNOLOGY. VOL. 3, ISSUES 1 TO 4, MARCH–DECEMBER 1953.) 2p. (Memo-CWT-5).

To study the effect of fission in initiating phase transformations in nonfissioning materials, 2 at. % Cr–U alloy was irradiated. The results show that temperature distribution in a thermal spike can be calculated but the material does not follow these temperatures by undergoing phase transformations according to the phase diagram. The spike may be regarded as a highly disorganized zone which reverts to the original structure and orientation with interstitials and vacancies which may annihilate each other, diffuse, or agglomerate. (T.R.H.)

**17394** TID-2504(Del.)(p.337-9)
Oak Ridge National Lab., Tenn.
CATHODIC PROTECTION OF TYPE 347 STAINLESS STEEL EXPOSED TO URANYL SULFATE SOLUTIONS. M. H. Lietzke. p.337-9 [of] NUCLEAR SCIENCE AND TECHNOLOGY. (EXTRACTS FROM REACTOR SCIENCE AND TECHNOLOGY. VOL. 3, ISSUES 1 TO 4, MARCH–DECEMBER 1953.) 3p.

Cathodic protection does not significantly decrease the corrosion rate of 347 stainless steel in $UO_2SO_4$ solutions at 100°C. In the presence of chloride ion the rate of corrosion may actually be increased owing to reactions which follow the liberation of chlorine at the platinum anode. At 250°C cathodic protection decreases by a factor of about 2.3 the corrosion rate of type 347 stainless steel in uranyl sulfate solutions containing 300 g of uranium per liter. Increasing the current density above 15 ma/sq ft seems to have no further effect on reducing the rate of corrosion. (auth)

**17395** TID-2504(Del.)(p.341-4)
Knolls Atomic Power Lab., Schenectady, N. Y.
A PRELIMINARY NOTE ON THE EFFECT OF NEUTRON IRRADIATION UPON SPECIMENS OF NATURAL-URANIUM WIRE. Myron B. Reynolds. p.341-4 [of] NUCLEAR SCIENCE AND TECHNOLOGY. (EXTRACTS FROM REACTOR SCIENCE AND TECHNOLOGY. VOL. 3, ISSUES 1 TO 4, MARCH–DECEMBER 1953). 4p.

Uranium wire 0.028-in. diam. was prepared, tested for ductility, and subjected to $5.5 \times 10^{18}$ nvt in the Brookhaven Reactor. The results suggest a slight increase in Young's modulus both for beta-treated and alpha-annealed, although the changes are near the experimental error. (T.R.H.)

**17396** TID-2504(Del.)(p.345-8)
Oak Ridge National Lab., Tenn.
CAPTURE CROSS SECTION OF $Pa^{233}$ FOR THERMAL REACTOR NEUTRONS. J. Halperin, C. V. Ellison, D. E. Ferguson, and R. W. Stoughton. p.345-8 [of] NUCLEAR SCIENCE AND TECHNOLOGY. (EXTRACTS FROM REACTOR SCIENCE AND TECHNOLOGY. VOL. 3, ISSUES 1 TO 4, MARCH–DECEMBER 1953.) 4p.

The silver-uranium system was constructed from data obtained by thermal, microscopic, and x-ray analyses. The important features of the system include: (1) A monotectic at 0.23 wt. % of silver and 1132°C with a liquid miscibility gap extending from 0.23 wt. % to approximately 94.5 wt. % of silver. (2) A eutectic at approximately 5 wt. % of uranium and 950°C. (3) The solubility of uranium in silver appeared to be between 0.1 and 0.4 wt. %, whereas no appreciable solubility of silver in uranium was noted. (4) The gamma-beta and the beta-alpha transformations of uranium were apparently unaffected by silver. (auth)

**17397** TID-2504(Del.)(p.349-51)
California Research and Development Co., [Livermore, Calif.]
A THEORY OF THE DIMENSIONAL INSTABILITY OF ALPHA URANIUM UNDER REACTOR IRRADIATION. Max Bettman. p.349-51 [of] NUCLEAR SCIENCE AND TECHNOLOGY. (EXTRACTS FROM REACTOR SCIENCE AND TECHNOLOGY. VOL. 3, ISSUES 1 TO 4, MARCH–DECEMBER 1953.) 3p. (LWS-24904).

A theory is developed for predicting the growth of single alpha-U crystals subjected to neutron irradiation by extending the idea of thermal spikes. Dimensional instability can be described by considering the local thermal distribution along the path of a fission fragment. A rough calculation is made of U growth under no external stress. (T.R.H.)

**17398** TID-2504(Del.)(p.353-8)
National Bureau of Standards, Washington, D. C.
THE SILVER–URANIUM SYSTEM. R. W. Buzzard, D. P. Fickle, and J. J. Park. p.353-8 [of] NUCLEAR SCIENCE AND TECHNOLOGY. (EXTRACTS FROM REACTOR SCIENCE AND TECHNOLOGY. VOL. 3, ISSUES 1 TO 4, MARCH–DECEMBER 1953.) 6p.

By irradiating Th slugs for varying periods of time, both at Hanford and in the LITR, and by analyzing the separated uranium mass spectroscopically for its $U^{234}$ content, the effective neutron-capture cross section of $Pa^{233}$ was measured as 152 ± 15 barns. The close agreement between the average values for the two reactors (153 at Hanford and 151 in the LITR) suggests a small resonance contribution and hence that 152 barns may be close to the thermal value. (auth)

**17399** TID-2505(Del.)
Technical Information Service, AEC.
NUCLEAR SCIENCE AND TECHNOLOGY. (EXTRACTS FROM REACTOR SCIENCE AND TECHNOLOGY. VOL. 4, ISSUES 1 TO 4, MARCH–DECEMBER 1954.) Decl. with deletions Feb. 26, 1957. 210p. $31.80(ph OTS); $9.30(mf OTS).

About twenty one papers are presented in this issue. Separate abstracts have been prepared for each paper. (W.L.H.)

**17400** TID-2505(Del.)(p.1-12)
Vitro Corp., of America, New York.
INORGANIC ION EXCHANGE FOR RARE-EARTH REMOVAL FROM AQUEOUS REACTOR FUELS. Harold F. Reichard, John D. McAdoo, Jr., and Gloria E. Kline. p.1-12 [of] NUCLEAR SCIENCE AND TECHNOLOGY. (EXTRACTS FROM REACTOR SCIENCE AND TECHNOLOGY. VOL. 4, ISSUES 1 TO 4, MARCH–DECEMBER 1954.) 12p.

Studies have been conducted on inorganic agents for the removal of rare-earth fission-product ions from short-cooled $UO_2SO_4-D_2O$ fuel solution to permit direct recycle of the fuel to a homogeneous reactor. The capacities of several of these inorganic agents for cerium and other rare-earth removal are described, together with their solubilities in the solution. The agents having the best combination of adsorptive capacity, low uranium removal, and minor effects on other ions are calcium fluoride at 100°C and titanite (complex calcium-containing silicate mineral) at 250°C. (auth)

**17401** TID-2505(Del.)(p.13-32)
Oak Ridge National Lab., Tenn.
THE RADIATION CHEMISTRY OF AQUEOUS REACTOR SOLUTIONS. PART 3. HOMOGENEOUS CATALYSIS OF THE HYDROGEN–OXYGEN REACTION. H. F. McDuffie, E. L. Compere, H. H. Stone, Lim F. Woo, and C. H. Secoy. p.13-32 of NUCLEAR SCIENCE AND TECHNOLOGY. (EXTRACTS FROM REACTOR SCIENCE AND TECHNOLOGY. VOL. 4, ISSUES 1 TO 4, MARCH–DECEMBER 1954). 20p.

Hydrogen and oxygen, dissolved in aqueous solutions at elevated temperatures, have been found to react smoothly to form water when dissolved copper salts are present in the solution as homogeneous catalysts. This reaction is important to the development of aqueous homogeneous reactors because it provides a possible means for suppressing the formation of hydrogen–oxygen gas bubbles from the decomposition of water by fission fragments. The kinetics of the reaction have been investigated over wide ranges of controllable variables, including environmental conditions of interest to the reactor program. (The rate-determining step appears to be the reaction of dissolved hydrogen with the dissolved copper catalyst, the reaction appears to be first order in dissolved hydrogen and dissolved copper, the rate is independent of the oxygen concentration over very wide ranges, and the activation energy appears to be approximately 24 kcal/mole.) Preliminary examination of a large number of inorganic compounds has not disclosed any homogeneous catalyst superior to copper for this reaction. (auth)

**17402** TID-2505(Del.)(p.33-45)
Oak Ridge National Lab., Tenn.
THE THOREX PROCESS. Alan T. Gresky. p.33-45 [of] NUCLEAR SCIENCE AND TECHNOLOGY. (EXTRACTS FROM REACTOR SCIENCE AND TECHNOLOGY. VOL. 4, ISSUES 1 TO 4, MARCH–DECEMBER 1954). 13p.

The Thorex process is being developed for the purpose of separating and decontaminating thorium, $U^{233}$, and $Pa^{233}$ from neutron-irradiated thorium. Designed initially for the processing of aluminum-clad thorium slugs, the process may be modified for use with other reactor materials, such as thorium oxide or oxycarbonate. It is a solvent-extraction process which employs tri-n-butyl phosphate as the extractant, nitric acid as the thorium-dissolution agent, and either aluminum nitrate or nitric acid as the salting agent. Final isolation of the $U^{233}$ product is accomplished by ion exchange. Progress in the laboratory-development phase of the Thorex program at Oak Ridge National Lab. is reported. (auth)

**17403** TID-2505(Del.)(p.47-72)
Oak Ridge National Lab., Tenn.
POWER REMOVAL FROM BOILING HOMOGENEOUS REACTORS. Paul C. Zmola, Wayne S. Brown, and Raymond V. Bailey. p.47-72 [of] NUCLEAR SCIENCE AND TECHNOLOGY. (EXTRACTS FROM REACTOR SCIENCE AND TECHNOLOGY. VOL. 4, ISSUES 1 TO 4, MARCH–DECEMBER 1954). 26p.

Calculations have been performed based on simple theoretical models postulating both natural vapor rise and natural circulation as the method of vapor transport in the core. The natural-circulation systems appear most promising, and the results of these calculations are presented in the form of performance charts. Experiments have been performed on six natural-vapor-rise systems and on one natural-circulation system in which boiling was produced by electrical-resistance heating of the liquid or was simulated by bubbling air through the apparatus. It has been possible to represent data from all these systems on one graph by employing an expression of the form $DG/\mu Z^{1/4} = \psi(1-\bar{\rho}/\rho_f)$. The circulating system exhibited the most favorable power-removal capability. Separation of vapor from the entraining fuel solution appears to be possible when centrifugal separators similar to those employed in large steam generators are used. Core arrangements in which vapor separation is obtained are considered briefly. Simple calculations indicate that a large reactor can be operated at a mean density decrease up to 40% without requiring excessive enrichment. Power fluctuations were measured in the circulating system and were found to decrease strongly with increased operating pressure. (auth)

**17404** TID-2505(Del.)(p.73-92)
Division of Reactor Development, AEC.
THE AEC PROGRAM FOR DEVELOPING NUCLEAR-POWER-PLANT TECHNOLOGY. Lawrence R. Hafstad. p.73-92 [of] NUCLEAR SCIENCE AND TECHNOLOGY. (EXTRACTS FROM REACTOR SCIENCE AND TECHNOLOGY. VOL. 4, ISSUES 1 TO 4, MARCH–DECEMBER 1954). 20p.

During the next few years the Atomic Energy Commission program for developing nuclear power plant technology will emphasize the parallel development of four promising approaches to competitive nuclear power based on (1) water reactors, (2) sodium-cooled thermal reactors, (3) aqueous homogeneous reactors, and (4) sodium-cooled fast reactors. The principal aim of this development program is to provide the technology needed for the evaluation and economic design of nuclear power plants. Except for the Pressurized Water Reactor project now under way, that part of the program which is supported primarily by government funds will consist of the basic development and the construction of experimental reactors designed to provide technology rather than to demonstrate large-scale generation of power. (auth)

**17405** TID-2505(Del.)(p.107-25)
Carbide and Carbon Chemicals Co. Y-12 Plant, Oak Ridge, Tenn.
MINIMUM CRITICAL MASS AND UNIFORM THERMAL-NEUTRON CORE FLUX IN AN EXPERIMENTAL REACTOR. John W. Morfitt. p.107-25 [of] NUCLEAR SCIENCE AND TECHNOLOGY. (EXTRACTS FROM REACTOR SCIENCE AND TECHNOLOGY. VOL. 4,

ISSUES 1 TO 4, MARCH–DECEMBER 1954). 19p.

The relation between minimum critical mass and uniform thermal-neutron core flux has been experimentally investigated in a water-moderated, water-reflected nuclear reactor employing $U^{235}$ as fuel. The theoretical fuel distribution was that given by Goertzel, who demonstrated mathematically that the condition of minimum critical mass in a suitably chosen thermal reactor required that the thermal-neutron flux be uniform everywhere in the core. The results clearly establish the validity of the Goertzel theory. The experimentally determined critical height and mass, using the theoretically determined fuel loading, were within 2.5% of the corresponding calculated parameters. The importance function for the fuel was shown to be constant throughout the core as required for a minimum-critical-mass reactor. The measured thermal and non-thermal components of the neutron flux were in good agreement with theory. The longitudinal neutron flux behaved as expected, and the reactor was found to be essentially thermal as demanded by the Goertzel theory. An exploratory investigation to obtain experimental verification of a modification of the theory made by Goertzel to predict how the critical mass of fuel can be minimized in a reactor of less than optimum radius met with little success. Although some lowering of the critical mass occurred, a discrepancy of more than 35% was found to exist between theory and experiment. (auth)

**17406** TID-2505(Del.)(p.127-38)
Knolls Atomic Power Lab., Schenectady, N. Y.
FURTHER CONSIDERATIONS ON THE DIMENSIONAL INSTABILITY OF URANIUM. J. E. Burke and Anna M. Turkalo. p.127-38 [of] NUCLEAR SCIENCE AND TECHNOLOGY. (EXTRACTS FROM REACTOR SCIENCE AND TECHNOLOGY. VOL. 4, ISSUES 1 TO 4, MARCH–DECEMBER 1954). 12p.

The dimensional changes occurring in uranium during irradiation continue to be a matter of practical concern and scientific interest. Recent experiments have established with more certainty the relations among texture, reactor behavior, and thermal-cycling behavior. Thermal-cycling and irradiation behaviors of polycrystalline uranium have a similar dependence upon texture. However, uranium single crystals, which are stable during thermal cycling, distort markedly during irradiation, indicating a fundamental difference in mechanism between thermal-cycling and irradiation behaviors. Apparently, during thermal-cycling a grain-boundary thermal ratchet operates to cause growth, whereas during irradiation the distortion occurs either through an anisotropic relaxation (by "kinking" or slip) of stresses or through anisotropic diffusion of displaced atoms. Two experiments are outlined that would aid in deciding between the two latter mechanisms. The effect of composition on the stability of uranium during irradiation needs a more systematic investigation to determine whether alloying additions do more than permit the uranium to be heat-treated to a fine-grained randomly oriented alpha-phase structure that is stable during irradiation. (auth)

**17407** TID-2505(Del.)(p.163-6)
Los Alamos Scientific Lab., N. Mex.
TEST-TUBE REACTOR. Harold M. Busey and R. Philip Hammond. p.163-6 [of] NUCLEAR SCIENCE AND TECHNOLOGY. (EXTRACTS FROM REACTOR SCIENCE AND TECHNOLOGY. VOL. 4, ISSUES 1 TO 4, MARCH–DECEMBER 1954). 4p.

An aqueous homogeneous reactor design is proposed which is intended to eliminate many of the disadvantages attendant to the operation of such reactors at a high power level. Heat is removed from $UO_2SO_4$ solution by natural convection from a hot-tube critical central region to axially located cooling coils outside the critical region. A catalytic recombiner is located above the liquid-gas interface. The advantages of this arrangement for high-flux operation are discussed. (W.L.H.)

**17408** TID-2505(Del.)(p.167-76)
Knolls Atomic Power Lab., Schenectady, N. Y.
COMPACT REACTOR POWER PLANT WITH COMBINATION HEAT EXCHANGER–THERMOELECTRIC PUMP. Emmeth A. Luebke and Leonard B. Vandenberg. p.167-76 [of] NUCLEAR SCIENCE AND TECHNOLOGY. (EXTRACTS FROM REACTOR SCIENCE AND TECHNOLOGY. VOL. 4, ISSUES 1 TO 4, MARCH–DECEMBER 1954). 10p.

A compact reactor power plant is described in which the reactor proper is located within a cylindrical heat exchanger. The pumping action in this liquid-metal-cooled reactor system is obtained in combination with the heat-exchanger function. By interposing thermoelements a large thermoelectric current is generated in the cylindrical heat exchanger by means of the temperature gradient normally existing between hot and cold tubes. With suitable pole pieces this current produces a perpendicular magnetic field and develops sufficient force on the liquid metal for the desired pumping action. (auth)

**17409** TID-2505(Del.)(p.187-8)
Bendix Aviation Corp. Research Labs., Detroit.
LIGHT-WATER BOILING IN NATURAL-URANIUM REACTORS. Francis E. O'Meara. p.187-8 [of] NUCLEAR SCIENCE AND TECHNOLOGY. (EXTRACTS FROM REACTOR SCIENCE AND TECHNOLOGY. VOL. 4, ISSUES 1 TO 4, MARCH–DECEMBER 1954.) 2p.

A natural-U, $H_2O$-cooled reactor design is proposed which would eliminate the danger of a positive temperature coefficient of reactivity, thus enhancing the desirability of further investigations on boiling heat-transfer methods. Cooling water-channel corrections to age and diffusion lengths have been carried out by two-group calculations, indicating the feasibility of balancing neutron absorption in the water by an equal opposite change in neutron leakage. (W.L.H.)

**17410** TID-2505(Del.)(p.189-96)
Sylvania Electric Products Inc. Atomic Energy Div., Bayside, N. Y.
THE ELASTIC PROPERTIES OF URANIUM IN COMPRESSION. Nicholas Grossman and Seymour Priceman. p.189-96 [of] NUCLEAR SCIENCE AND TECHNOLOGY. (EXTRACTS FROM REACTOR SCIENCE AND TECHNOLOGY. VOL. 4, ISSUES 1 TO 4, MARCH–DECEMBER 1954). 8p. (SEP-137).

The object of this investigation was, first to determine whether or not the engineering stress-strain curve for U in uniaxial compression slows a straight-line portion and, second to compare the modulus of elasticity in compression with published values for the modulus in tension. Other elastic properties, namely, Poisson's ratio and the derived values for shear and bulk moduli, as well as modulus of resilience, proportional limit, and yield strength, were also obtained. A secondary purpose of this investigation was to determine the effect of strain hardening on the elastic properties. (auth)

**17411** TID-2505(Del.)(p.197-200)
Battelle Memorial Inst., Columbus, Ohio.
A NOTE ON THE URANIUM–TITANIUM CONSTITUTIONAL DIAGRAM. H. A. Saller and F. A. Rough.

p.197-200 [of] NUCLEAR SCIENCE AND TECHNOLOGY. (EXTRACTS FROM REACTOR SCIENCE AND TECHNOLOGY. VOL. 4, ISSUES 1 TO 4, MARCH–DECEMBER 1954). 4p.

In the course of the preparation and study of uranium–titanium alloys for corrosion evaluation, it became apparent that metallographic observations could not be accounted for on the basis of the current diagram of the system. As a result a brief study of the portion of the system in the vicinity of the intermediate phase was carried out. The work consisted of thermal analyses and metallographic studies. The results indicated that the intermediate phase, designated as "epsilon," was stable only to about 890°C. Corresponding alteration of the associated two-phase regions was also indicated. (auth)

**17412** TID-2505(Del.)(p.201-6)
Battelle Memorial Inst., Columbus, Ohio.
A NOTE ON THE METASTABLE GAMMA PHASE IN URANIUM–MOLYBDENUM ALLOYS. H. A. Saller, F. A. Rough, and A. A. Bauer. p.201-6 [of] NUCLEAR SCIENCE AND TECHNOLOGY. (EXTRACTS FROM REACTOR SCIENCE AND TECHNOLOGY. VOL. 4, ISSUES 1 TO 4, MARCH–DECEMBER 1954). 6p.

It has been known for some time that the addition of about 20 to 30 at.% molybdenum to uranium produces a metastable gamma-uranium phase. It had been thought that this phase was stable, and, in spite of the more recent contrary evidence, this concept has had a tendency to persist. Recently molybdenum alloys became of interest for use in high-temperature water and, more specifically, for application in the Pressurized Water Reactor. The phase formed during transformation is body-centered tetragonal with $c_0 = 6.55$ A and $a_0 = 6.84$ A. These data coupled with resistance measurements indicate that the transformation is probably an ordering reaction. Metallographic and hardness data were also included. Additional work in the progress to obtain more definitive results on the kinetics of transformation of these alloys. (auth)

**17413** TID-2505(Del.)(p.207-9)
Monsanto Chemical Co., St. Louis.
ADVISORY COMMITTEE ON REACTOR SAFEGUARDS. C. Rogers McCullough. p.207-9 [of] NUCLEAR SCIENCE AND TECHNOLOGY. (EXTRACTS FROM REACTOR SCIENCE AND TECHNOLOGY. VOL. 4, ISSUES 1 TO 4, MARCH–DECEMBER 1954.) 3p.

General principles to be considered by the Advisory Committee on Reactor Safeguards in reviewing proposed reactor construction are outlined. (W.L.H.)

**17414** TID-2505(Del.)(p.211-18)
SEPARATION OF $Pa^{233}$ AND $U^{233}$. Helen P. Raaen and Paul F. Thomason. p.221-18 [of] NUCLEAR SCIENCE AND TECHNOLOGY. (EXTRACTS FROM REACTOR SCIENCE AND TECHNOLOGY. VOL. 4, ISSUES 1 TO 4, MARCH–DECEMBER 1954). 8p.

Because of the importance of the isolation of $U^{233}$, especially from $Pa^{233}$, the paper chromatographic method was evaluated for the $Pa^{233}$–$U^{233}$ separation; the results of this evaluation are discussed herein. The effectiveness of the separation was confirmed by autoradiographic studies with the purest solutions of $Pa^{233}$ and $U^{233}$ available. A practical application of the method was demonstrated with solutions very similar to Thorex process solutions. The scintillation spectrometer was used to identify the radionuclides isolated from the process type solutions. (auth)

**17415** TID-2505(Del.)(p.219-21)
Oak Ridge National Lab., Tenn.
A SIMPLIFIED FORMULA FOR THE MULTIPLICATION CONSTANT OF INTERMEDIATE REACTORS. C. B. Mills. p.219-21 [of] NUCLEAR SCIENCE AND TECHNOLOGY. (EXTRACTS FROM REACTOR SCIENCE AND TECHNOLOGY. VOL. 4, ISSUES 1 TO 4, MARCH–DECEMBER 1954.) 3p.

The spatial distribution of fission-producing neutrons is essentially set up in the moderation-diffusion process before many fission absorptions have occurred. A separation of the fast diffusion (and fast-neutron escape) and the absorption processes is therefore possible with small errors. Below this point of separation the scattering cross section of most elements is a constant, and the complications of fission-neutron spectrum, etc., have disappeared. It is proposed that an "experimental" number, made to include the processes above the point of separation, might greatly simplify the problem of obtaining reasonably accurate critical-mass (from $k_{eff}$) values. (auth)

**17416** TID-2505(Del.)(p.223-5)
Argonne National Lab., Lemont, Ill.
MULTIGROUP PARAMETERS AND CRITICAL CALCULATIONS IN $D_2O$-MODERATED SYSTEM. B. I. Spinrad and Katsumi Tanaka. p.223-5 [of] NUCLEAR SCIENCE AND TECHNOLOGY. (EXTRACTS FROM REACTOR SCIENCE AND TECHNOLOGY. VOL. 4, ISSUES 1 TO 4, MARCH–DECEMBER 1954). 3p.

For systems with heavy-water moderation, critical properties calculated on the standard two-group picture disagree with experimental results. Since the slowing-down kernel may be approximated better by a three-group picture, it is desirable to do three-group calculations using, insofar as possible, information obtained from two-group calculations. A way of converting from two-group to three-group constants is exhibited, and an iterative process which leads to rapid convergence of the critical concentration of fuel is outlined. (auth)

**17417** TID-2505(Del.)(p.227-36)
North American Aviation, Inc., Downey, Calif.
FLAT-FLUX REACTORS. E. R. Cohen and F. B. Estabrook. p.227-36 [of] NUCLEAR SCIENCE AND TECHNOLOGY. (EXTRACTS FROM REACTOR SCIENCE AND TECHNOLOGY. VOL. 4, ISSUES 1 TO 4, MARCH–DECEMBER 1954). 10p.

Multigroup diffusion theory is used to derive a set of coupled total differential equations for a reactor having a spatially variable fuel density and consequent constant thermal neutron flux throughout the reactor. This approach offers some advantages over the integral equations of Goertzel for a flat-flux reactor, such as treating the condition where the reflector has different neutron properties from the core. Minimum critical mass considerations are not emphasized, in favor of showing that the flat-flux condition has other more important advantages in power reactors. Plane parallel, spherically symmetric, and cylindrically symmetric geometries are considered. (W.L.H.)

**17418** TID-2505(Del.)(p.237-41)
North American Aviation, Inc., Downey, Calif.
FLAT-FLUX CORES. Ralph Balent. p.237-41 [of] NUCLEAR SCIENCE AND TECHNOLOGY. (EXTRACTS FROM REACTOR SCIENCE AND TECHNOLOGY. VOL. 4, ISSUES 1 TO 4, MARCH–DECEMBER 1954). 5p.

A convenient and simple method for calculating the critical size, mass, and fuel distribution for a flat

thermal flux across a reactor core is discussed. Diffusion theory is used for two neutron groups with spherical geometry and a finite reflector. (W.L.H.)

**17419** TID-2505(Del.)(p.243-8)
North American Aviation, Inc., Downey, Calif.
THERMAL DIFFUSION LENGTH IN HETEROGENEOUS MEDIUMS. S. W. Kash and F. B. Estabrook. p.243-8 [of] NUCLEAR SCIENCE AND TECHNOLOGY. (EXTRACTS FROM REACTOR SCIENCE AND TECHNOLOGY. VOL. 4, ISSUES 1 TO 4, MARCH–DECEMBER 1954). 6p.

Measurement of the thermal neutron diffusion length, L, for a multiplying heterogeneous medium is considered. The validity of taking of $L^2 = 1/3\overline{\Sigma}_a\ \overline{\Sigma}_{tr}$ is examined, where the superposed bars indicate volume averages over a lattice cell, with various volumes weighted according to their average thermal-neutron fluxes. The calculation of $\overline{\Sigma}$ involves experimentally determined values of the disadvantage factors F and $F_m$, where F is the ratio of the thermal-neutron flux on the surface of the rod to the average flux within, and $F_m$ is the ratio of average moderator flux to that at the rod surface. Experiments reported from Argonne and NAA on rod lattices in $D_2O$ moderator showed that values of $L^2$ were 20 to 25% higher than those predicted. Remeasurements were performed using Pb–Cd alloy rods, simulating the absorption and transport properties of low–enrichment U, but without obscuring the thermal diffusion process by neutron multiplication. These results are presented for 4 nonmultiplying lattices, and it is shown that agreement between experimental and theoretically predicted values of $L^2$ is excellent. (W.L.H.)

**17420** TID-2505(Del.)(p.249-55)
Brookhaven National Lab., Neutron Cross Section Compilation Group, Upton, N. Y.
RECENT THERMAL-NEUTRON CROSS-SECTION DATA. [John A. Harvey.] p.249-55 [of] NUCLEAR SCIENCE AND TECHNOLOGY. (EXTRACTS FROM REACTOR SCIENCE AND TECHNOLOGY. VOL. 4, ISSUES 1 TO 4, MARCH–DECEMBER 1954.) 7p.

A table of recent thermal neutron cross section data is presented for a number of important isotopes. Data for the tables were taken from BNL-250. (W.L.H.)

**17421** TID-2506(Del.)
Technical Information Service, AEC.
NUCLEAR SCIENCE AND TECHNOLOGY. (EXTRACTS FROM NUCLEAR SCIENCE AND TECHNOLOGY. VOL. 1, ISSUES 1 TO 3, FEBRUARY–JUNE 1955). Decl. with deletions Feb. 26, 1957. 190p. $28.80(ph OTS); $8.40(mf OTS).

Twelve papers are included in this issue. Separate abstracts have been prepared for each paper. (W.L.H.)

**17422** TID-2506(Del.)(p.1-14)
Argonne National Lab., Lemont, Ill.
SOME ASPECTS OF STORED ENERGY IN IRRADIATED GRAPHITE. PART I. KINETICS OF THE RELEASE. William Primak. p.1-14 [of] NUCLEAR SCIENCE AND TECHNOLOGY. (EXTRACTS FROM NUCLEAR SCIENCE AND TECHNOLOGY. VOL. 1, ISSUES 1 TO 3, FEBRUARY–JUNE 1955.) 14p.

Previous scientific studies of the release of stored energy in irradiated graphite are briefly reviewed against the background of studies of the kinetics of the annealing of radiation damage in graphite. It is concluded that the postulation of a quasi-continuous distribution of activation energies for annealing gives the best explanation of the data at present available. The problem of the behavior of kinetic processes distributed in activation energy is considered, and V. Vand's treatment of them is extended. It is shown that most of the stored-energy data gathered in the past are not suitable for detailed kinetic analysis and cannot be used for much more than to derive an approximate activation-energy spectrum. An exception is found in some experimental data reported by J. C. Ballinger. It is shown how data of this kind can afford a means of determining the order of reaction and the frequency factor as well as the activation-energy spectrum. Ballinger's data suggest an order less than unity (the physical conditions from which such a result can arise are suggested) and a frequency factor between $10^{10}$ and $10^{14}$ $sec^{-1}$. However, his data are not sufficiently precise to fix these quantities with certainty. (auth)

**17423** TID-2506(Del.)(p.15-38)
North American Aviation, Inc., Downey, Calif.
MEASUREMENTS AND ANALYSIS OF URANIUM–$D_2O$ LATTICES. Frank B. Estabrook and Sidney W. Kash. p.15-38 [of] NUCLEAR SCIENCE AND TECHNOLOGY. (EXTRACTS FROM NUCLEAR SCIENCE AND TECHNOLOGY. VOL. 1, ISSUES 1 TO 3, FEBRUARY–JUNE 1955). 24p.

During the past few years an extensive series of measurements on low-enrichment uranium-rod lattices in $D_2O$ have been carried out at North American Aviation, Inc. This article briefly summarizes the measured values of the material bucklings, the fuel and moderator disadvantage factors, and the activity ratios for all the lattices and then gives the details and results of a careful two-group analysis into the consistency and significance of the measurements. The effective thermal-neutron temperature of each lattice is obtained from the ratio of absorption cross section to low-energy slowing-down power. The slowing-down power of $D_2O$ in the thermal region is shown to be 0.173 $cm^{-1}$, and some agreement with experimental values of the average cosine in a scattering collision is adduced. Thermal utilizations are obtained from the experimental intracell measurements. Comparison is made with diffusion calculations of rod disadvantage factors and with excess absorption calculations for the moderator. Calculated in conventional fashion are $\eta$, $\epsilon$, and $L^2$; in $L^2$ it may be noted that experimental disadvantage factors are used. The ratio of thermal to epithermal foil activities is shown to be a parameter characteristic of the asymptotic lattice spectrum and is successfully correlated with the predictions of two-group theory. The possible use of this experimental ratio for determining lattice diffusion lengths is critically examined. The neutron ages in the various lattices are computed by taking the lower limit of the age integral at an effective thermal energy some 16 times greater than would be proper in a nonmultiplying medium. The resonance escape probabilities that can be computed from the above quantities are then compared with resonance escape probabilities computed from the usual Fermi-Wigner-Weinberg theory. A series of small, but definite, discrepancies, functions of rod uranium enrichment, are found. These are believed to be real and independent of experimental scatter. Three supplemental experiments are recorded in the appendixes. These indicate the presence of a small amount of anisotropic diffusion, show the thermal utilization to be independent of large flux gradients that exist near the boundary of an exponential tank, and support the method used for computing effective neutron ages. (auth)

**17424** TID-2506(Del.)(p.39-55)
Argonne National Lab., Lemont, Ill.
RECOVERY OF FISSIONABLE MATERIAL FROM EN-

RICHED-URANIUM FUELS. PART II. EXPERIMENTAL BREEDER REACTOR FUEL ELEMENTS. Leslie Burris, Jr., S. Lawroski, M. Levenson, R. C. Vogel, and S. Vogler. p.39-55 [of] NUCLEAR SCIENCE AND TECHNOLOGY. (EXTRACTS FROM NUCLEAR SCIENCE AND TECHNOLOGY. VOL. 1, ISSUES 1 TO 3, FEBRUARY–JUNE 1955). 17p.

The first core loading of the Experimental Breeder Reactor was of unalloyed enriched uranium. A solvent-extraction recovery scheme for this core material using tri-n-butyl phosphate is described. The process consists of a single extraction-scrub-strip cycle. The extraction of fission-product zirconium is minimized by complexing with oxalate ion, and the extraction of the small amounts of plutonium is minimized by reducing to the trivalent state. The laboratory data leading to the process flow sheet are presented. The results of the semi-works investigation of the process at the West Stands and the operation of a second unit at Lemont are described. (auth)

**17425** TID-2506(Del.)(p.57-71)
Brookhaven National Lab., Upton, N. Y.
THE VARIATION OF $\alpha^{U^{235}}$ WITH ENERGY IN THE INTERMEDIATE-ENERGY RANGE. Sophie Oleksa. p.57-71 [of] NUCLEAR SCIENCE AND TECHNOLOGY. (EXTRACTS FROM NUCLEAR SCIENCE AND TECHNOLOGY. VOL. 1, ISSUES 1 TO 3, FEBRUARY–JUNE 1955). 15p.

Recent experiments have made possible a new evaluation of resonance parameters for some of the low-energy levels of $U^{235}$. The data permit a numerical calculation of the variation of $\alpha^{U^{235}}$ with energy in the range from 100 to 100,000 ev in accordance with a method proposed by E. P. Wigner. The effects of fitting the experimental data with several different distributions were examined, and the results are as follows: (1) The variation of $\alpha^{U^{235}}$ with energy is a slow one, no matter which of several distributions is assumed to hold for the fission and scattering widths. (2.) The different distributions used give values of $\alpha$ that do not differ markedly. (3.) The values obtained by means of Wigner's theory are in good agreement with results of the Knolls Atomic Power Laboratory integral experiments. (4.) The theory can be applied with confidence to fissionable materials other than $U^{235}$ for which comparable information about low-energy resonances is available. (auth)

**17426** TID-2506(Del.)(p.73-89)
Oak Ridge National Lab., Tenn.
HRE EXPERIMENTS ON INTERNAL RECOMBINATION OF GAS WITH A HOMOGENEOUS CATALYST. S. Visner and Paul N. Haubenreich. p.73-89 [of] NUCLEAR SCIENCE AND TECHNOLOGY. (EXTRACTS FROM NUCLEAR SCIENCE AND TECHNOLOGY. VOL. 1, ISSUES 1 TO 3, FEBRUARY–JUNE 1955.) 17p.

The use of copper dissolved in the reactor fuel for the complete recombination of radiolytic gas has been successfully demonstrated in the Homogeneous Reactor Experiment. Copper ion was added as copper sulfate on four occasions, increasing the copper concentration to 10, 25, 75, and 150% of the estimated concentration necessary for complete recombination in a static system at 250°C, at 1000-psig total pressure, and at a uniform power density of 20 kw/liter. The investigation was conducted at temperatures from 185 to 260°C, at pressures from 765 to 1200 psig, and at power levels as high as 1600 kw. In the main the copper behaved as expected from previous static bomb tests; the reactor data have been shown to be consistent with the laboratory data if it is postulated that a small but relatively stagnant region exists in the core with characteristics predicted from mixing experiments with a plastic model. The highest power level for which all the gas was internally recombined was 1350 kw. In the course of all copper experiments, including 350 hr of operation at the highest copper concentration, 0.06 mole/liter, no deleterious effects due to the presence of copper observed. (auth)

**17427** TID-2506(Del.)(p.103-23)
Oak Ridge National Lab., Tenn.
A CONCEPTUAL DESIGN FOR THE ARMY PACKAGE POWER REACTOR. Robert S. Livingston. p.103-23 [of] NUCLEAR SCIENCE AND TECHNOLOGY. (EXTRACTS FROM NUCLEAR SCIENCE AND TECHNOLOGY. VOL. 1, ISSUES 1 TO 3, FEBRUARY–JUNE 1955.) 21p.

Small compact "package" reactor power plants have been proposed for use in remote locations. Such a package reactor power plant, rated at 1000 kw of net electric power and 3500 kw of stream for heating purposes, has been designed. The total thermal output of the reactor is 10,000 kw. The fuel plates consist of highly enriched $UO_2$ embedded in a matrix of stainless steel, with stainless-steel cladding. The core is moderated and cooled with circulating water, pressurized to 1200 psia. The saturated steam that drives the turbogenerator is produced in a heat exchanger at 200 psia. Steam from the heat exchanger is also used, at a reduced pressure, for space heating. The reactor is loaded with approximately 18 kg of $U^{235}$ and will supply 15 Mw-years of energy before refueling is required. This corresponds to 2.5 years of operation at an average load factor of 60%. Burn-out poison in the form of $B_4C$ is incorporated to reduce the reactivity excursion and thus facilitate control. The major objective was to design a reactor that would require a minimum of development effort and yet be reliable and inexpensive. The estimated capital investment, exclusive of development work and exclusive of uranium, is $1,700,000. The estimated cost per kilowatt-hour for net electric and steam power at the bus, based on a 60% average load demand, is 5.33 and 1.23 cents, respectively. (auth)

**17428** TID-2506(Del.)(p.125-41)
Brookhaven National Lab., Upton, N. Y.
A GAS-COOLED LIQUID-METAL REACTOR. Harold L. Falkenberry, C. J. Raseman, William A. Robba, Thomas V. Sheehan, and Lincoln D. Stoughton. p.125-41 [of] NUCLEAR SCIENCE AND TECHNOLOGY. (EXTRACTS FROM NUCLEAR SCIENCE AND TECHNOLOGY. VOL. 1, ISSUES 1 TO 3, FEBRUARY–JUNE 1955). 17p.

A helium-cooled liquid-metal-fuel reactor with a graphite core structure is described. The fuel is a solution of uranium in molten bismuth. The graphite is composed of blocks containing vertical holes for the fuel and horizontal holes for the helium coolant, which passes directly through the core to the turbine. The light-metal fuel circulates slowly at a rate sufficient for fuel processing. The reflector material is graphite, and, if breeding is desired, the fertile material is a thorium-bismuth slurry. A major advantage of this system lies in the ability of the closed-cycle gas turbine to efficiently utilize the clean inert high-temperature gas from a nuclear reactor in the direct production of useful power. The power-plant equipment can be made compact by the use of elevated pressures. As suitable materials of construction for higher temperatures are developed, further increases in efficiency can be realized by the closed-cycle plant. The system studied will produce 60 mega-watts at the generator terminals at an

over-all efficiency of 40.4 per cent. The turbine inlet temperature is 1400°F, and the maximum system pressure is 1000 psi. The reactor core is a 5-ft cube contained in a 14-ft-diameter spherical vessel, and the maximum fuel temperature is 1800°F. (auth)

**17429** TID-2506(Del.)(p.143-4)
RAND Corp., Santa Monica, Calif.
A HYBRID-REACTOR PROPOSAL. George Safonov. p.143-4 [of] NUCLEAR SCIENCE AND TECHNOLOGY. (EXTRACTS FROM NUCLEAR SCIENCE AND TECHNOLOGY. VOL. 1, ISSUES 1 TO 3, FEBRUARY-JUNE 1955.) 2p.

A hybrid reactor which incorporates the stability of the homogeneous reactor with the high conversion ratio of a Kouts-Chernick lattice is proposed. (auth)

**17430** TID-2506(Del.)(p.145-59)
Knolls Atomic Power Lab., Schenectady, N. Y.
PLUTONIUM POWER REACTOR WITH OXIDE FUEL AND BLANKET ELEMENTS. John B. Sampson and Emmeth A. Luebke. p.145-59 [of] NUCLEAR SCIENCE AND TECHNOLOGY. (EXTRACTS FROM NUCLEAR SCIENCE AND TECHNOLOGY. VOL. 1, ISSUES 1 TO 3, FEBRUARY-JUNE 1955). 15p.

Increased capital costs of a reactor power system make it desirable to seek reduced fuel charges below the 2 to 4 mills/kw-hr of coal- or oil-fired systems. An inexpensive procedure for recovering plutonium from the core and blanket of a breeder and for refabricating it into fuel structures offers an attractive possibility for reducing fuel costs. A fuel element consisting of plutonium and uranium oxide in steel tubing and capable of a large fraction of fuel burn-up is described. This fuel element makes possible recovery and refabrication with fewer steps than are required for a metal fuel element and, therefore, results in lower recycle costs. Breeders with fuel and fertile material in both oxide and metallic form were analyzed by the multigroup method on the UNIVAC for the purpose of comparing characteristics. A summary is presented of the nuclear data assumed, the method of calculation, and the results obtained. The decrease in the breeding ratio resulting from the replacement of the metal core by oxide is only 0.2, which is a small effect in a future nuclear power economy, where plutonium has a low value as fuel rather than a high value as weapon material. Use of an oxide blanket may reduce the breeding ratio by 0.05. An illustrative design is presented which has five atoms of uranium per atom of plutonium in the core and 45% sodium and which has a breeding ratio of 1.4 and a critical mass of 400 kg. Incremental refueling is assumed to reduce the control range required for 50% burn-up of the original fuel loaded. (auth)

**17431** TID-2506(Del.)(p.181-8)
Oak Ridge National Lab., Tenn.
RADIOACTIVITY IN REACTOR COOLING WATER. W. S. Lyon, Jr. and S. A. Reynolds. p.181-8 [of] NUCLEAR SCIENCE AND TECHNOLOGY. (EXTRACTS FROM NUCLEAR SCIENCE AND TECHNOLOGY. VOL. 1, ISSUES 1 TO 3, FEBRUARY-JUNE 1955). 8p.

Short-, intermediate-, and long-lived radioactivity in the cooling water of the ORNL LITR was determined. Activities reported are due to induced activity in water impurity and to fission products. (W.L.H.)

**17432** TID-2506(Del.)(p.189-92)
Oak Ridge National Lab., Tenn.
A METHOD OF ESTIMATING THE $N^{16}$ CONTENT IN THE COOLING SYSTEM OF AN MTR TYPE REACTOR. F. T. Binford. p.189-92 of NUCLEAR SCIENCE AND TECHNOLOGY. (EXTRACTS FROM NUCLEAR SCIENCE AND TECHNOLOGY. VOL. 1, ISSUES 1 TO 3, FEBRUARY-JUNE 1955). 4p.

General equations are developed for predicting the $N^{16}$ activity in reactor coolants, considering $O^{16}(n,p)$ and $O^{16}(n,\gamma)$ reactions. (W.L.H.)

**17433** TID-2506(Del.)(p.201-6)
Oak Ridge National Lab., Tenn.
CONTINUOUS REPURIFICATION OF LITR COOLING WATER. J. A. Cox, William R. Casto, and William H. Tabor. p.201-6 [of] NUCLEAR SCIENCE AND TECHNOLOGY. (EXTRACTS FROM NUCLEAR SCIENCE AND TECHNOLOGY. VOL. 1, ISSUES 1 TO 3, FEBRUARY-JUNE 1955.) 6p.

A description is given of a mixed-bed bypass demineralizer which was installed in the LITR cooling water system to reduce radioactivity and increase water purification. Conditions which necessitated using the demineralizer are also discussed. The effects of such installations on corrosion and radioactivity are given. (auth)

**17434** TID-2508(Del.)
Technical Information Service, AEC.
NUCLEAR SCIENCE AND TECHNOLOGY. VOL. 1A, ISSUE 3, DECEMBER 1955. Decl. with deletions Mar. 6, 1957. 118p. $18.30(ph OTS); $6.00(mf OTS).

Six papers are included in this issue. Separate abstracts have been prepared for each paper. (W.L.H.)

**17435** TID-2508(Del.)(p.383-93)
Oak Ridge National Lab., Tenn.
NEUTRON-INDUCED FISSION CROSS SECTION OF $U^{238}$ FROM 0.5 TO 4.0 MEV NEUTRON ENERGY. R. W. Lamphere. p.383-93 [of] NUCLEAR SCIENCE AND TECHNOLOGY. VOL. 1A, ISSUE 3, DECEMBER 1955. 11p.

The fission cross section of natural uranium has been measured from 500 kev to 4.0 Mev neutron energy using protons from the Oak Ridge 5-Mv Van de Graaff to bombard a tritium-gas target. Neutron energy spread varied from 60 to 100 kev for most points. Data were corrected for the $U^{235}$ present in natural U in order to get the cross section of $U^{238}$. With the energy spread present in the neutron beam, no minimums were found, but there are a few features worthy of note. The $U^{238}$ cross-section curve has a much longer low-energy "tail" than either $U^{234}$ or $U^{236}$. The cross section is of the order of 0.4 mb at 500 kev. It gradually rises to 17 mb at 950 kev, remains constant to 1.05 Mev, rises to 40 mb at 1.16 Mev, remains constant to 1.23 Mev, and then rises in a normal manner to 0.54 barn at 2.0 Mev and to 0.58 barn at 3.0 Mev. At about 3 Mev the cross section begins to increase more rapidly with energy, reaching 0.65 barn at 4.0 Mev. Results are believed to be good to 6%. (auth)

**17436** TID-2508(Del.)(p.395-407)
Sylvania Electric Products, Inc., [Bayside, N. Y.]
SOLID-STATE BONDING AND CANNING OF THORIUM WITH ALUMINUM. Samuel Storchheim. p.395-407 [of] NUCLEAR SCIENCE AND TECHNOLOGY. VOL. 1A, ISSUE 3, DECEMBER 1955. 13p.

Hot-pressure-welding studies of both wrought and powder-metallurgy thorium and 2S aluminum were conducted. The resultant data showed that bond strengths as high as 7800 psi could be obtained by the proper combination of hot-pressing temperature, pressure, and time. The intermetallic alloy zones formed between the two components showed an increase in width with both increasing temperature and pressure. The requisite conditions for best bonding were applied to the canning

of Th slugs 6 in. in length by 1 in. in diameter in Al cans of 35-mil wall thickness. It was found that the canned Th was uniformly well bonded to the Al. In addition, the bond areas were found to have a high degree of corrosion resistance to 170°C steam. (auth)

**17437** TID-2508(Del.)(p.409-44)
Argonne National Lab., Lemont, Ill.
THE FABRICATION OF FUEL ELEMENTS FOR POWER REACTORS. James F. Schumar. p.409-44 [of] NUCLEAR SCIENCE AND TECHNOLOGY. VOL. 1A, ISSUE 3, DECEMBER 1955. 36p.

Methods for the manufacture of Zr-clad U plates and Zircaloy-2-clad U–Nb–Zr alloy plates for water-cooled power reactors are described. The basic technique consists of enclosing the core in a can of the jacket material to form a composite billet, which is then enclosed in a steel can and hot rolled into a flat plate. Various methods of fabricating the plates, the effect of billet atmosphere on bonding, the advantages of various billet shapes, and corrosion testing and inspection of the plates are discussed. Fuel plates for reactors using high-energy neutrons must have a high surface-to-volume ratio and have adequate corrosion resistance to coolants such as liquid Na. Techniques for roll bonding stainless steel of Ni to U with Ag as the bonding medium have been developed for this type of fuel plate. The fabrication of large numbers of small-dimension enriched-U fuel components with thin sections can be accomplished by multiple mold centrifugal casting. The casting machine and procedures are described. (W.L.H.)

**17438** TID-2508(Del.)(p.445-61)
Argonne National Lab., [Lemont, Ill.].
A DESIGN STUDY OF TWO HELIUM-COOLED REACTORS. Robert H. Armstrong, Adolf Lovoff, and Lyman J. Templin. p.445-61 [of] NUCLEAR SCIENCE AND TECHNOLOGY. VOL. 1A, ISSUE 3, DECEMBER 1955. 17p.

A conceptual design for two reactors, one of 500-Mw and the other of 189-Mw heat output, is presented. The reactors are cooled with helium so that they can be matched to an external closed-cycle gas-turbine system. The helium operates at a pressure of 100 psi and a reactor outlet temperature of 1400°F. Because of the high temperatures, graphite moderator and thorium fuel are considered. The 500-Mw reactor operates with 17.5 tons of Th containing 3.61 wt. % $U^{233}$, the 189-Mw reactor operates with 6.2 tons of Th containing 3.47 wt. % $U^{233}$. Both reactors have initial conversion ratios of approximately 0.92 and require an indeterminate extra enrichment for long-term operation. The primary design limit chosen is that of a maximum heat flux of 291,000 Btu/hr/sq ft. Materials temperature limitations are roughly compatible with this value. (auth)

**17439** TID-2508(Del.)(p.481-511)
[Oak Ridge National Lab., Tenn.].
FABRICATION OF ZIRCALOY-2 CORE VESSEL FOR THE HOMOGENEOUS REACTOR TEST. [W. R. Gall and G. E. Elder.] p.481-511 [of] NUCLEAR SCIENCE AND TECHNOLOGY. VOL. 1A, ISSUE 3, DECEMBER 1955. 31p.

Pictures are presented to show the equipment and methods used in fabricating the zircaloy-2 core vessel for the HRT. Techniques illustrated include forming, machining, welding, and hydrostatic testing. (W.L.H.)

**17440** TID-2508(Del.)(p.513-15)
Argonne National Lab., [Lemont, Ill.]
SPONTANEOUS IGNITION OF HIGHLY IRRADIATED FUEL. J. H. Kittel. p.513-15 [of] NUCLEAR SCIENCE AND TECHNOLOGY. VOL. 1A, ISSUE 3, DECEMBER 1955. 3p.

Several instances of highly irradiated fuel specimens igniting spontaneously and burning to oxide are described. All of the 5 specimens which ignited had had their surface to mass ratios greatly increased by extensive roughening. There appears to be a critical time after exposure to air when a specimen is most apt to ignite. If the specimen survives this period, it will then slowly oxidize in the same manner as unirradiated fuel. (W.L.H.)

**17441** UCRL-5355-T
[California. Univ., Livermore. Radiation Lab.]
PRELIMINARY STUDIES ON ELECTRICAL PROPULSION SYSTEMS FOR SPACE TRAVEL. Robert H. Fox. [Sept. 22, 1958]. 17p. Contract [W-7405-eng-48]. $3.30(ph OTS); $2.40(mf OTS).

A brief description of the flight mechanics of both low and high acceleration for interplanetary missions is presented. It is shown that the low acceleration systems pay a large penalty in total momentum change requirements. An optimization procedure for low acceleration systems is given which leads to a simple relationship between mission requirements, payload fraction, power plant specific power, and exhaust velocity. The energy limitation for electric propulsion systems utilizing a nuclear energy source is described and shown to give an upper limit to the mission of about $2 \times 10^5$ m/sec for current technology. It is shown that electric propulsion systems with a specific power capability of 0.1 kw/kg can complete favorably with chemical or heat exchanger type nuclear hydrogen rockets for the Mars mission and are much superior for missions to the outer planets. The hardware problems associated with the attainment of a specific power of 0.1 kw/kg for an electric propulsion system are described. (auth)

**17442** USNRDL-TR-252
Naval Radiological Defense Lab., San Francisco.
THERMAL RADIATION DAMAGE TO CELLULOSIC MATERIALS. PART III. IGNITION OF ALPHA CELLULOSE BY PULSES SIMULATING NUCLEAR WEAPON AIR BURSTS. S. B. Martin and W. Lai. May 28, 1958. 40p. (AFSWP-1082).

The ignition behavior of blackened alpha-cellulose exposed to the generalized nuclear weapon (air burst) pulse is detailed for a wide range of simulated weapon yield. As in the case of square-wave exposure, the data are correlated to a single ignition behavior pattern using grouped parameters derived from considerations of diffusion of heat. The behavior when exposed to the two input types is seen to be quite similar. However, no simple equivalence expression results as in the case of charring. Equivalent effects are observed for weapon pulses having peak irradiances about three times the irradiance level of the square-wave input. Sustained flaming ignition requires up to 40 percent less energy and sustained glowing requires up to a third more energy when delivered in the form of the weapon pulse. (auth)

**17443** AEC-tr-3282
CATHODIC DEPOSITION OF METALS. II. X-RAY INVESTIGATION OF ELECTROLYTIC NICKEL. G. L. Clark and P. K. Frölich. Translated by K. S. Bevis (Savannah River Lab.) from Z. Elektrochem. 31, 655-8 (1925). 8p.

Nickel films, deposited on platinum from various electrolytes under various temperatures and concentration conditions, were used as well as plates which were separated from nickel and aluminum electrodes.

The results obtained by studying 30 x-ray photographs of nickel deposits are briefly summarized. (W.D.M.)

**17444** AERE-Lib/Trans-794
ON THE THERMAL CONDUCTIVITY OF LIQUIDS. L. Graetz. Translated by E. Franklin (U.K.A.E.A. Atomic Energy Research Establishment) from Ann. Phys. Chem. 18, 79-94(1883). 13p.

The method and theory of the experiment are described, and results are given for the thermal conductivity of distilled water, copper sulfate solution, ethyl alcohol, sodium chloride solution, zinc sulfate solution, and spirits of turpentine. (J.E.D.)

**17445** NP-tr-152
ON CERTAIN RESULTS OF DETERMINING THE ELECTRON CONCENTRATION OF THE OUTER REGIONS OF THE IONOSPHERE BY MEANS OF OBSERVATIONS OF RADIO SIGNALS FROM THE FIRST ARTIFICIAL SATELLITE. Ia. L. Al'pert, F. F. Dobriakova, E. F. Chudesenko, and B. S. Shapiro. Translated for [Lincoln Lab., MIT] from Uspekhi Fiz. Nauk 65, 161-74 (1958). 26p.

As is known, the first earth satellite was provided with a self-contained radio transmitter operating at 20 and 40 mc. The low absorption in the ionosphere of the radiowaves being emitted by the satellite would guarantee reliable reception of the radio signals. Consequently, it appeared to be possible to obtain a number of new results on the properties of the ionosphere by analyzing the appropriate results of the radio observations. One of the possible methods of observing the satellite radio signals, based on determining the instants of its "radio-rise" and "radio-set," which would permit the electron concentration distribution of the ionosphere above the maximum to be determined is described herein. Preliminary results of appropriate processing of the experimental results are presented. An analysis of the results of the research leads to certain important and interesting representations of the outer ionosphere; quantitative characteristics of the diminution of the electron concentration and the neutral particle density here, as well as certain considerations on the "boundary" where the atmosphere joins the interplanetary gas, are obtained. (auth)

**17446** NP-tr-154
ON THE RESULTS OF DETERMINING THE ELECTRON CONCENTRATION OF THE OUTER REGIONS OF THE IONOSPHERE BY MEANS OF OBSERVATIONS ON THE RADIO SIGNALS OF THE FIRST SATELLITE. Ia. L. Al'pert, F. F. Dobriakova, E. F. Chudesenko, and B. S. Shapiro. Translated by Morris D. Friedman (Lincoln Lab., MIT) from Doklady Akad. Nauk S.S.S.R. 120, 743-6(1958). 9p.

Briefly described are the results of observations on radio signals of the satellite, based on determining the instants of its "radio rise" and "radio set." Data on the distribution of the electron concentration of the ionosphere above its maximum and the preliminary reasoning on the properties of the interplanetary gas resulting therefrom have been obtained. (auth)

**17447**
POSSIBILITY OF OBTAINING ATOMIC ENERGY WITHOUT USING A CHAIN REACTION. K. Simonyi (Central Research Inst. of Physics, Hungarian Academy of Sciences, Budapest). Acta Phys. Acad. Sci. Hung. 6, No. 1, 157-60(1956). (Translated from Referat. Zhur. Fiz. No. 5, 1957, Abstract No. 11254).

The possibility of empolying an exothermal synthesis reaction (for example, the reaction $T^3(d,n)He^4$) in accelerators carrying high currents is considered for the production of atomic energy.

**17448**
VACUUM ELECTRODYNAMICS ON A MERRY-GO-ROUND. John Ise and Jack L. Uretsky (Univ. of California, Berkeley). Am. J. Phys. 26, 431-5(1958) Oct.

Maxwell's equations in a relativistic, rotating reference frame are discussed by use of a covariant formalism. (auth)

**17449**
THE EFFECT OF GETTERING ON THE REFLECTIVITY OF ALUMINIUM FILMS. L. Holland (Edwards High Vacuum Ltd., Crawley, Sussex, Eng.). Brit. J. Appl. Phys. 9, 330-3(1958) Aug.

Aluminum films evaporated on glass from a single vapor source are more optically absorbing at high angles of vapor incidence if the films are slowly deposited or prepared in a poor vacuum. The rise in the optical absorption with vapor incidence angle is attributed to the degree of gas contamination of the growing film increasing as the deposition becomes more oblique. Such an effect could arise from a greater ratio of the number of gas molecules to vapor atoms combining at the receiver in regions of low vapor intensity. The reflectivities of aluminum films prepared at different gas pressures and rates of deposition show qualitative agreement with the hypothesis when plotted as a function of vapor incidence angle. The simple theory advanced is not applicable at gas pressures above 1 $\mu$ mercury because the vapor atoms are scattered by gas molecules before striking the receiver. (auth)

**17450**
PHASE TRANSFORMATIONS WHEN WATER IS COMPRESSED BY STRONG SHOCK WAVES. L. V. Altschuler, A. A. Bakanova, and R. F. Trunin. Doklady Akad. Nauk S.S.S.R. 121, 67-9(1958) July 1. (In Russian)

Data are presented on the shock wave compression of water in the compression range from 20,000 to 800,000 atm. (R.V.J.)

**17451**
ON A VARIATION PRINCIPLE IN THE PROBLEM OF MANY BODIES. S. V. Tyablikov (Steklov Inst. of Math. Academy of Sciences, USSR.). Doklady Akad. Nauk S.S.S.R. 121, 250-2(1958) July 11. (In Russian)

A variation is formulated for the problem of many bodies in which the given solution of the generalized method produces the minimum energy of the basic state, which converges to the condition of positiveness in the second variation expression for the basic state energy. A criterion is found where the normal Fock method does not offer the energy minimum and the latter must be searched for in a more extensive range of generalized method solutions. The new method can be applied in investigations of solid body electron theory, and in calculations of crystalline lattice, as for example, in determining the criterion of superconductivity considering the lattice. (R.V.J.)

**17452**
THE STRUCTURE OF THE ENERGY SPECTRUM OF ELECTRONS IN IRON – CHROMIUM ALLOYS. N. D. Borisov, V. V. Nemoshkalenko, and A. M. Fefer (Inst. of Metal Physics, Academy of Sciences, Ukrainian SSR). Doklady Akad. Nauk S.S.S.R. 121, 264-7(1958) July 11. (In Russian)

The structure of x-ray emission $K_{\beta_5}$ lines of chromium and iron in Cr–Fe alloys was investigated. The characteristic changes in the electron energy spectra of

chromium and iron in transition into alloy and in transition on the temperature axis of Fe–Cr alloys into $\alpha$ and $\beta$ phase are determined. (R.V.J.)

**17453**

LONGITUDINAL DIFFUSIVITY OF LIQUIDS IN PACKED BEDS. David A. Strang and Christie J. Geankoplis (Ohio State Univ., Columbus). Ind. Eng. Chem. 50, 1305-8(1958) Sept.

Methods for determining the longitudional diffusivities of liquids in flowing beds are discussed. One method is to inject a sudden concentration signal into the fluid at the inlet and to measure the change in the signal with time at the outlet. Another method, which is the main subject of consideration, is the frequency response technique method in which a continuous sine wave is introduced at the inlet. Equations are derived and extended for liquids using concentration units, instead of mole fraction units as were used in the basic theory put forth by Rosen and Winsche (Chem. Phys. 18 1587 (1950)). (J.R.D.)

**17454**

FACTORS DETERMINING THE OXYGEN CONTENT OF LIQUID SILICON AT ITS MELTING POINT. W. Kaiser (Bell Telephone Labs., Murray Hill, N. J.) and J. Breslin (Signal Corps Engineering Labs., Fort Monmouth, N. J.). J. Appl. Phys. 29, 1292-4(1958) Sept.

The oxygen content of liquid silicon increases proportionally to the oxygen content of the ambient helium-oxygen mixture for oxygen partial pressures $po_2° < 8$ mm Hg. This observation is explained by the proportionality between the oxygen partial pressure $po_2°$ in the ambient gas and the SiO partial pressure on the surface of liquid silicon. For $po_2° > 8$mm Hg the silicon melt is covered by a film of silica and a saturation value of about $2 \times 10^{18}$ oxygen atoms per $cm^3$ is observed in the crystallized sample. (auth)

**17455**

PRIMARY PYROELECTRICITY IN BARIUM TITANATE CERAMICS. T. A. Perls, T. J. Diesel, and W. I. Dobrov (Lockheed Missile Systems Division, Palo Alto, Calif.). J. Appl. Phys. 29, 1297-1302(1958) Sept.

Data have been obtained on the pyroelectric and piezoelectric behavior of samples of a polycrystalline barium titanate ceramic in an effort to determine the possible existence of a primary pyroelectric effect. It is shown that the total pyroelectric effect is in a direction opposite to the piezoelectric contribution resulting from volumetric changes and that, as a consequence, there must exist a primary pyroelectric effect. The time constant of the samples for generation of electrical signals from heat pulses was less than 12 $\mu$sec. Practical applications of barium titanate sensors may be found in the measurement of heat radiation beams having large cross sections. (auth)

**17456**

HIGH-TEMPERATURE HEAT CONDUCTIVITY OF SOME METAL OXIDES. John C. Jamieson and A. W. Lawson (Univ. of Chicago.). J. Appl. Phys. 29, 1313-14(1958) Sept.

A reanalysis of data on the thermal conductivity of certain metal oxides has shown that the deviation from a $T^{-1}$ law may be fitted to a law exponential in $T^{-1}$. Thus the deviations may be ascribed to the flow of excitons. The contribution to the thermal conductivity from radiative transfer is shown to be too small to fit the observed deviations. (auth)

**17457**

PHENOMENOLOGICAL THEORY OF POLARIZATION REVERSAL IN $BaTiO_3$ SINGLE CRYSTALS. Charles F. Pulvari and Wolf Kuebler (Catholic Univ. of America, Wash.). J. Appl. Phys. 29, 1315-21(1958) Sept.

A theory describing polarization reversal in $BaTiO_3$ c-domain crystals based on observed time and field dependence of polarization $P=f(E,t)$ is presented, and the activation field $\alpha$ as well as mobility $\mu$ are related to the constants appearing in the basic differential equation. The theory gives time and field dependence of the switching current at constant temperature. Although the theory does not imply restriction on the applied field E(t), results are given only for pulsed and sinusoidal fields. The effect of skin properties on the bulk crystal has been considered. Dependence of coercive field on applied field and frequency are readily obtained. Switching resistance is calculated. (auth)

**17458**

TEMPERATURE DEPENDENCE OF MAGNETIC PROPERTIES OF SILICON–IRON. C. W. Chen (Westinghouse Research Labs., Pittsburgh, Penna.). J. Appl. Phys. 29, 1337-43(1958) Sept.

Permeability coercive force, remanence, and hysteresis and core losses of a 3% singly oriented silicon–iron alloy are measured in the temperature range of 30 to 700°C. Their temperature dependence is interpreted in terms of either the intrinsic properties of a ferromagnetic or domain theory. The magnetization curve is analyzed on the basis of the crystallographic characteristics of the texture in the material. Domain distribution is discussed at each stage of magnetization. Application of the analysis leads to the establishment of the relationship between the temperature coefficent of permeability and the magnetization processes. (auth)

**17459**

ABNORMALLY HIGH DETONATION PRESSURES IN A SHOCK TUBE. I. Ginsburgh (Standard Oil Co., Whiting, Ind.). J. Appl. Phys. 29, 1381-2(1958) Sept.

Several recent experiments in a shock tube resulted in unexpectedly high pressures which were estimated to be about 500 to 700 times the initial pressure. The details of these experiments are described, together with a possible explanation for the high pressure observed. (L.T.W.)

**17460**

QUANTUM STATISTICAL THEORY OF PLASMAS AND LIQUID METALS. Robert D. Cowan (Los Alamos Scientific Lab., N. Mex.) and John G. Kirkwood (Yale Univ., New Haven, Conn.). J. Chem. Phys. 29, 264-71 (1958) Aug.

A Debye-Hückel-type theory is described for an assembly of completely ionized atoms, the nuclei being treated classically and the electrons by the Thomas-Fermi method. The thermodynamic functions are derived by considering the Debye charging process, and the virial theorem is shown to hold. Numerical results are given for hydrogen and iron near normal solid densities, and are probably accurate only at high temperatures ($kT > 5$ ev for hydrogen and $kT > 100$ ev for iron). At these temperatures, the results do not differ greatly from those of the ordinary Thomas-Fermi theory of the atom except for the additional contributions of the nuclei. (auth)

**17461**

TEMPERATURE DEPENDENCE OF THE PHASE TRANSITION IN CERIUM. R. Herman and C. A. Swenson (Iowa State Coll., Ames). J. Chem. Phys. 29, 398-9(1958) Aug.

The cubic-condensed cubic transition in cerium has been observed as a function of temperature and pres-

sure from 360°K and 11,000 atm to 78°K and zero pressure. The data which were obtained definitely link the high pressure, room temperature and the low temperature, zero pressure transitions which have been observed previously. While the data show some unexplained features, the calculated value for the latent heat of transition at 288°K (1150 ± 100 cal/mole) agrees as to order of magnitude with a directly measured value (880 ± 40 cal/mole) by other workers. (auth)

**17462**

HEAT OF SUBLIMATION OF CARBON AND THE DISSOCIATION ENERGY OF CO BY X-RAY DENSITOMETRY OF SHOCK WAVES. H. T. Knight and J. P. Rink (Los Alamos Scientific Lab., N. Mex.). J. Chem. Phys. 29, 449-50(1958) Aug.

**17463**

ON THE ELECTRONIC STRUCTURE OF DIBORANE. Walter C. Hamilton (Brookhaven National Lab., Upton, N. Y.). J. Chem. Phys. 29, 460-1(1958) Aug.

**17464**

LOW TEMPERATURE HEAT CAPACITY OF BISMUTH AND TUNGSTEN. Warren DeSorbo (General Electric Research Lab., Schenectady, N. Y.). J. Phys. Chem. 62, 965-7(1958) Aug.

The heat capacities of bismuth and tungsten have been measured in the temperature region 15 to 90°K. At 298.1°K the entropies of these two metals have been re-evaluated. That of bismuth is 13.56 ± 0.05 cal g atom$^{-1}$ deg$^{-1}$, while that of tungsten is 8.2 ± 0.2 cal g atom$^{-1}$ deg$^{-1}$. The variation in the Debye characteristic temperature in the liquid hydrogen–liquid nitrogen temperature region for bismuth is similar to that characteristic of "layer-like" lattices, while that for tungsten is typical of some of the isotropic lattices. (auth)

**17465**

ULTRASONIC STUDIES IN ELECTROLYTE SOLUTIONS. SALTS OF HEAVY METALS. Bh. Krishnamurty and M. Satyanarayana Murty (Andhra Univ., Waltair). J. Sci. Ind. Research (India) 17B, 216-18(1958) June.

Ultrasonic velocities in aqueous solutions of salts of some heavy metals, viz. lead, thallium, thorium, and uranium, were determined at varying concentrations. Based on these determinations, the adiabatic compressibilities of the solutions were calculated. The ultrasonic velocities were found to decrease with increasing concentration of the salts in the solutions, contrary to the general variation of ultrasonic velocities in the case of other salts which show an increase in velocity. Ultrasonic velocities determined in a solution of a mixture of lead nitrate and acetate are lower than those obtained in solutions of individual salts. This confirms the view that the decrease in ultrasonic velocity in solutions of these salts is due to the presence of heavy metal ions. (auth)

**17466**

HEAT CONTENT OF ZIRCONIUM AND OF FIVE COMPOSITIONS OF ZIRCONIUM HYDRIDE FROM 0° TO 900°C. Thomas B. Douglas and Andrew C. Victor. J. Research Natl. Bur. Standards 61, 13-23(1958) July.

Using a precise Bunsen ice calorimeter, a "silver core" furnace, and a "drop" method, the heat content (enthalpy) of zirconium metal and five samples of zirconium hydride (24 to 52 atomic percent hydrogen) was measured over the range 0° to 900°C. Thermal hysteresis of the hydrides was investigated in several cases, and corrections were applied for the impurities in the samples. At each temperature up to 550°C the heat contents of the hydrides relative to 0°C were found to vary linearly with composition, a fact in accord with the phase diagram of the system. The effective heat capacity of each hydride sample reached its maximum value between 550° and 600°C, a behavior that can be interpreted as due to the endothermic formation of the high-temperature beta phase. (auth)

**17467**

NOMOGRAPHS FOR PARTICLE SIZE ANALYSIS BY SEDIMENTATION & PERMEABILITY METHODS. G. D. Joglekar and B. R. Marathe (National Physical Lab., New Delhi, India). J. Sci. Ind. Research (India) 17B, 232-5 (1958) June.

Two nomographs for particle size analysis by the sedimentation method based on Stokes' law and by air permeability method employing the apparatus developed by Lea and Nurse (Soc. Chem. Ind., Lond. 58 277(1939)) are described. (J.R.D.)

**17468**

CYLINDRICAL SHOCK WAVES FROM EXPLODING WIRES. F. D. Bennett (Aberdeen Proving Ground, Md.). Phys. Fluids 1, 347-52(1958) July-Aug.

A simple technique has been found for rendering visible the shock wave formed by an exploding wire after the shock has separated from the luminous contact surface. A small, plane mirror is placed just behind the wire so as to be perpendicular to the axis of the optical system. Thus the reflected image of the wire explosion coincides with the disturbance itself when seen through the slit by the camera lens. Rotating mirror pictures taken under these conditions show very clear outlines of the parabolic shock wave as it propagates ahead of the luminous contact surface. The separation of the shock and contact surface is complete by about one μsec. Beyond this time the shock is clearly nonluminous and ordinarily would not be visible. Comparison of shock trajectories with predictions from the similarity solutions for strong shock waves obtained by S. C. Lin may be interpreted as showing that the shock is receiving additional energy while traversing the early part of its path. After this phase both shock and contact surface accurately obey a parabolic law over intervals of several microseconds. (auth)

**17469**

EVAPORATION INTO A BOUNDARY LAYER. Ernest Bauer and Martin Zlotnick (AVCO, Wilmington, Mass.). Phys. Fluids 1, 355-6(1958) July-Aug.

The evaporation rate of a solid or liquid into a stream of gas flowing across its surface is considered as a function of surface temperature and of material and gas properties neglecting chemical reactions. One of the boundary conditions to be used at the interface between the gas and the solid (or liquid) is derived. (auth)

**17470**

THERMOELECTRIC POWER OF DILUTE INDIUM-LEAD AND INDIUM-THALLIUM ALLOYS. W. J. Tomasch and J. R. Reitz (Case Inst. of Tech., Cleveland). Phys. Rev. 111, 757-64(1958) Aug. 1.

An earlier investigation of the thermoelectric power of dilute (α-phase) indium-lead alloys, measured relative to pure indium, indicated that there is detailed structure superimposed on the smooth trend of the data. This investigation is now extended to include some twenty-two indium-lead alloys as well as thirteen indium-thallium alloys. For the indium-lead alloys, the existence of structure at both 273 and 77°K is reaffirmed. On the other hand, the thermoelectric power of the indium-thallium system is found to be an extremely smooth function of the composition in the same range of solute concentration. As a consequence, it is concluded that the observed structure in indium-lead is due exclusively to changes in electronic concentration brought

about by alloying. An estimate of the pure electronic concentration contribution to the thermoelectric power is obtained by subtracting the indium-thallium data from the corresponding indium-lead data. The results of this procedure are demonstrated to be in qualitative agreement with the predictions of a band-model theory which is developed for this comparison. It is therefore suggested that the observed structure can be attributed to the extinction of bands of electron holes and the initiation of bands of overlap electrons. Furthermore, as the result of comparing the thermoelectric data with lattice spacing information, definite suggestions are made concerning the band configuration of pure indium and the evolution of said configuration with alloying. Finally, a very qualitative explanation is offered for the novel face-centered tetragonal ($c/a > 1$) to face-centered tetragonal ($c/a < 1$) phase transformation which occurs at the $\alpha$-phase solubility limit. (auth)

**17471**

QUENCHED IMPERFECTIONS AND THE ELECTRICAL RESISTIVITY OF ALUMINUM AT LOW TEMPERATURES. Warren DeSorbo (General Electric Research Lab., Schenectady, N. Y.). Phys. Rev. 111, 810-12(1958) Aug. 1.

The electrical resistivity of a high-purity aluminum specimen, having different concentrations of "quenched-in" lattice defects, is reported for the temperature region 1 to 20°K. For small and different concentrations of structural impurities, the resistivity follows Matthiessen's rule. The exponential constant, n, in the equation, $p = p_i + AT^n$, is equal to 2.7 for the sample in a well-annealed state. This number increases slightly with an increase in defect concentration. (auth)

**17472**

MAGNETIC SUSCEPTIBILITY OF COPPER–NICKEL AND SILVER–PALLADIUM ALLOYS AT LOW TEMPERATURES. E. W. Pugh and F. M. Ryan (Carnegie Inst. of Tech., Pittsburgh). Phys. Rev. 111, 1038-42 (1958) Aug. 15.

The magnetic susceptibilities of copper-nickel alloys with up to 39 atomic % nickel and silver-palladium alloys with up to 10 atomic % palladium were measured by the Gouy method at temperatures between 295 and 2.1°K. Measurements are reported on samples with an impurity content of less than 10 ppm and on samples with greater impurity content. The susceptibility is nearly temperature-independent for all the silver-palladium alloys and for the copper-nickel alloys with up to 27% nickel. Higher nickel concentrations give rise to a $1/T$ susceptibility term which is too large to be accounted for by impurity content. The simple band model of Mott adequately describes the susceptibility of the silver-palladium alloys but fails to predict the large temperature-independent paramagnetic contribution of nickel in copper. Exchange energies calculated by the Stoner collective electron method for the copper-nickel alloys, using specific heat and susceptibility data, are somewhat unsatisfactory and suggest the presence of another mechanism. (auth)

**17473**

BROKEN ATOMIC BEAM RESONANCE EXPERIMENT. Daniel Kleppner, Norman F. Ramsey, and Paul Fjelstadt (Harvard Univ., Cambridge, Mass.). Phys. Rev. Letters 1, 232-3(1958) Oct. 1.

Cesium atoms from a heated oven were passed through a bouncing box, where they suffered at least two collisions, between two six-pole deflecting magnets. The characteristic Ramsey separated oscillatory field resonance pattern was found corresponding to atomic transitions between the F = 4, M = 0 and F = 3, M = 0 state. (W.D.M.)

**17474**

COLOUR CENTERS IN SYNTHETIC FLUORITE CRYSTALS. W. Bontinck (Laboratorium voor Kristalkunde, Gent, Belgium). Physica 24, 639-49(1958) Aug.

A study of the coloration of fluorite crystals after irradiation and additive coloration has been made. Bleaching experiments and lattice parameter measurement lead us to probable models for the $\alpha$ and $\beta$ centers. The $\beta$ center should be a normal F-center, the $\alpha$ center an F-center coupled to an interstitial fluorine ion. (auth)

**17475**

SPUTTERING OF A POLYCRYSTALLINE SILVER SURFACE BOMBARDED WITH MONOENERGETIC ARGON IONS OF LOW ENERGY (40-240 eV). M. Koedam (Fysich Laboratorium der Rijksuniversiteit, Utrecht, Netherlands). Physica 24, 692-4(1958) Aug.

A silver surface was bombarded with normally incident $Ar^+$ ions at several well defined energies ranging from 40 to 240 ev. The ions were extracted from a plasma created by an electron beam in argon gas at low pressure. The electron beam was kept together by an axial magnetic field. The energy of the $Ar^+$ ions was controlled by adjusting the potential difference of the Ag surface and the plasma. Measurements and calculations indicated that the mass ratio of the silver deposited on the glass plate to the total amount of sputtered silver is independent of the energy of the argon ions. (W.L.H.)

**17476**

A PERTURBATION CALCULATION OF PROPERTIES OF THE HELIUM ISO-ELECTRONIC SEQUENCE. A. Dalgarno and A. L. Stewart (Queen's Univ. of Belfast). Proc. Roy. Soc. (London) A247, 245-59(1958) Sept. 16.

Perturbation methods are employed to calculate the magnetic susceptibilities and the dipole polarizabilities of the ground states of the members of the helium iso-electronic sequences and also the mass polarization, relativistic, and radiative corrections to their energies, the results being obtained as power series in the inverse of the nuclear charges. The calculations are preferred by a brief résumé of the equations of perturbation theory applicable to the case when the unperturbed wave function is known only approximately. (auth)

**17477**

THE RELATIONSHIP BETWEEN ELECTRICAL AND THERMAL CONDUCTIVITIES OF TITANIUM ALLOYS. H. W. Deem, W. D. Wood, and C. F. Lucks (Battelle Memorial Inst., Columbus, Ohio). Trans. Met. Soc. AIME 212, 520-3(1958) Aug.

Electrical and thermal conductivity measurements have been made on titanium and 6 titanium alloys. The following expression was derived for calculating thermal conductivity from electrical conductivity: $K = 0.626\ \sigma\ T \times 10^{-6} + 0.00497$, where K = thermal conductivity, cal $sec^{-1}$ $cm^{-2}$ $cm°C^{-1}$, $\sigma$ = electrical conductivity, $ohm^{-1}$ $cm^{-1}$, and T = temperature, deg Kelvin. This expression gives calculated thermal conductivities that are not in error by more than 10% from the experimental values for A-55 titanium and the 6 alloys measured; namely, A-110AT, C-110M, C-130AM, Ti–6Al–4V, Ti-140A, and Ti-155A, which are representative of the presently available commercial $\alpha$ and $\alpha$-$\beta$ titanium alloys. (auth)

**17478**

ON THE THEORY OF EXCITATION OF HYDROMAGNETIC WAVES. A. I. Akhiezer and A. G. Sitenko (Inst. of Physics and Tech., Academy of Sciences, Ukrainian

SSR). Zhur. Eksptl'. i Teoret. Fiz. 35, 116-20(1958) July. (In Russian)

Excitation of hydromagnetic and magnetoacoustic waves by external currents is investigated. Damping of the waves due to conductivity and viscosity of the medium is taken into account. Excitation by currents is compared with excitation by mechanical means in respect to intensity. (tr-auth)

**17479**

TRANSACTIONS OF THE AMERICAN NUCLEAR SOCIETY. A Supplement to Nuclear Science and Engineering, Volume 1, Number 1, June 1958. New York, Academic Press, Inc., 1958. 192p.

The programs and technical summaries of the papers presented at the national meeting of the American Nuclear Society at Los Angeles June 2-5, 1958, are presented. Papers are included on reactor theory, kinetics, and engineering, corrosion, metallurgy, chemistry and processing, shielding, etc. (W.D.M.)

## Cosmic Radiation

**17480**

DENSITY SPECTRUM OF EXTENSIVE SHOWERS OF COSMIC RAYS AT AN ALTITUDE OF 230 METERS ABOVE SEA LEVEL. A. Zaivadski. Bull. Acad. Polon. Sci. 3,5, No. 2, 147-53(1957). (Translated from Referat. Zhur. Fiz. No. 1, 1958, Abstract No. 572)

Experimental data show that the spectrum of extensive showers can be represented in the following differential form: $N(\rho)d\rho = K\rho^{-(\sigma+1)}\,d\rho$, where N is the number of showers with a density lying between $\rho$ and $\rho + d\rho$, K is a constant, whose value depends on the depth of the point of observation in the atmosphere, and $\gamma$ varies slowly as a function of $\rho$. To determine the function $\gamma(\rho)$, a hodoscope of three groups, each containing 18 Geiger-Mueller counters, was used. 227,712 individual records of individual groups were obtained. The function measured in this manner is $\gamma = 1.323 + 0.064 \ln(1 + 0.043\,\rho\ln)$, where $\rho\ln$ is the density corresponding to the most probable value of $\ln\rho$. It is proven that the function $\gamma(\rho)$ cannot be represented as a linear dependence on $\ln\rho$ of the type $\gamma = a + b \ln\rho$, with a probability greater than 0.0001.

**17481**

INVESTIGATION OF EXTENSIVE AIR SHOWERS CONTAINING NUCLEAR ACTIVE PARTICLES. G. Bozóki, E. Fenyves, T. Sándor, and A. Somogyi (Central Research Inst. of Physics, Budapest). Nuclear Phys. 7, 677-86 (1958) Aug.

The exponent of the density spectrum of the electronic component of extensive air showers containing nuclear active particles was determined to be $\gamma = 1.34 \pm 0.08$ assuming that the density of nuclear active particles is proportional to the density of electrons in air showers. The agreement of the exponent found in the present experiment with that determined earlier for extensive air showers ($\gamma = 1.43 \pm 0.02$) with the same arrangement, which however, consisted only of the electron detectors supports the above assumption. From this it follows that the density spectrum of nuclear active particles has the form of a power law with an exponent approximately equal to $\gamma$. Furthermore, the decoherence curve between the electron and nuclear active particle detectors was measured. The experimental results are briefly discussed. (auth)

**17482**

THE CHARGE SPECTRUM OF THE COSMIC RADIATION AT 41° N. M. Koshiba, G. Schultz, and Marcel Schein (Univ. of Chicago). Nuovo cimento (10) 9, 1-16 (1958) July 1.

From a large stack of G-5 emulsions flown at Texas, 41°N geomagnetic latitude, the charge spectrum of the cosmic radiation at 104,000 feet was obtained. Special emphasis is given to the observation of the detailed shape of the spectrum in the region $Z \geq 9$. The gap-counting is extensively used even at these high Z values after very careful calibration with break-up events and δ-ray countings. The charge spectrum thus obtained was extrapolated to the top of the atmosphere by making use of the fragmentation probabilities in air which were obtained from the analysis of a total of 209 interactions in the same stack. This extrapolation gives for the ratio of the light nuclei, L, ($Z = 3, 4,$ and 5) and the heavy nuclei, H, ($Z \geq 9$), to the medium ones, M, ($Z = 6, 7,$ and 8) the values $0.32 \pm 0.07$ and $0.48 \pm 0.10$, respectively, at the top of the atmosphere. The fragmentation probabilities in hydrogen, the main constituent of interstellar matter, were also obtained from the careful study of the interactions in the stack and allowed to make a further extrapolation of the charge spectrum from the top of the atmosphere to the one at the source region of the cosmic radiation. The ratio of the heavy nuclei to the medium ones was found to be $0.66 \pm 1.6$ at the source. This charge spectrum at the source region is compared with the average chemical abundances of the elements in the universe as well as with those in certain types of stars. The results seem to indicate a close similarity of the chemical abundance curve of the cosmic radiation with that of certain types of young stars. (auth)

**17483**

THE ZENITHAL DISTRIBUTION OF THE COSMIC RAY NEUTRONS IN THE HIGH ENERGY RANGE. M. Cervasi Fidecaro, G. Fidecaro, G. Marini, and L. Mezzetti (Univ. of Rome and Istituto Nazionale di Fisica Nucleare, Rome). Nuovo cimento (10) 9, 37-58 (1958) July 1.

The zenith-angle distribution of cosmic neutrons in the energy range $\gtrsim 10$ Bev has been measured at an altitude of 3,500 m above sea level (679 g $cm^{-2}$) by means of a penetrating shower detector associated with a large area Geiger counter hodoscope. The penetrating showers were generated in thin layers of paraffin and graphite. The instrumental bias and the systematic errors in the determination of the angles are discussed, and corrections applied whenever possible. The corrected distribution is well approximated with a law of the type $\exp[-m/\cos\theta]$ with $m = 7.1 \pm 1.3$, in agreement with experimental results. The discussion shows that this value has to be considered as a lower limit for the true m and is therefore difficult to reconcile with the assumption that the zenithal distribution is due solely to the absorption of the particles of the nuclear cascade in the atmosphere, with a mean free path $\lambda_a = 130$ g $cm^{-2}$ as determined by several authors. From the hodoscope information the angular distribution of ionizing secondaries around the direction of the primary neutron is also calculated. The distributions obtained for penetrating showers produced in carbon and in hydrogen are very similar. The analysis in terms of an isotropic distribution in the center of mass system of the incident neutron and a target nucleon yields an average energy of the observed events $\bar{E} = 24$ Bev. The experimental results on the zenithal distribution are compared with the distributions calculated with the theory of the nuclear cascade in the atmosphere. It is shown that the finite lifetime of some of the particles belonging to the N component cannot account for the anomalous zenithal effect indicated by the measurements. It is suggested that the discrep-

ancy may be removed with the choice of a sufficiently large value of the anelasticity parameter. (auth)

**17484**

NUMERICAL CALCULATIONS ON THE NEW APPROACH TO THE CASCADE THEORY. III. S. K. Srinivasan, J. C. Butcher, B. A. Chartres, and H. Messel (Univ. of Sydney). Nuovo cimento (10) 9, 77-84(1958) July 1.

On the basis of the new approach to the cascade theory accurate numerical results on the mean numbers of electrons produced in small thicknesses in a shower initiated by a single electron or photon are presented. Agreement with the experimental results is satisfactory if due allowance is made for tridents. (auth)

**17485**

LATITUDE VARIATION OF 27-DAY COSMIC RAY INTENSITY DECREASES. R. R. Brown (Univ. of California, Berkeley). Nuovo cimento (10) 9, 197-207(1958) July 16.

The latitude variation of cosmic-ray intensity decreases due to the modulation effects of a geocentric nebula of disordered magnetic fields has been calculated. Experimental data provided by neutron monitor observations during a period of intense solar activity, when compared with the results of these calculations, show that equatorial variations exceed those given by the modulation mechanism by a factor of two or more. (auth)

**17486**

HEMISPHERICAL DISTRIBUTION OF COSMIC RAYS AT 25° GEOMAGNETIC LATITUDE. P. S. Gill and A. N. Mitra (Muslim Univ., Aligarh). Nuovo cimento (10) 9, 400-11(1958) Aug. 1.

A complete investigation was made of the angular distribution (over various zeniths and azimuths) of the hard component of cosmic rays at the Gulmarg High Altitude Research Observatory (Geomagnetic latitude 24.7° N). The azimuth distribution is found to agree closely with an energy law $E^{-1.80}dE$ for all the zenith angles. The zenithal distribution is found to be a cosine power law in which the index "n" varies regularly with azimuth. A sinusoidal dependence of "n" on azimuth was obtained by the method of least squares. (auth)

**17487**

SHORT $\gamma$-RAY BURST FROM A SOLAR FLARE. L. Peterson and J. R. Winckler (Univ. of Minnesota, Minneapolis). Phys. Rev. Letters 1, 205-6(1958) Sept. 15.

During a balloon flight in Cuba a short burst of radiation coincident with a class II solar flare was observed at 1305 UT on March 20, 1958. Associated with this flare were ionospheric disturbances, a magnetic crotchet and earth current disturbance, and solar radio emission at 3 and 27 cm. It is concluded that the observations can be accounted for by electrons on the solar surface accelerated to about 1 Mev during the growth of the flare. (W.D.M.)

**17488**

STUDY OF $\mu$ MESONS OF COSMIC RAYS IN THE STRATOSPHERE. P. Ch. Ageshin and I. N. Charakhch'yan. Vestnik Moskov Inst. Ser. Mat. Mekh. Astr. Fiz. Khim. No. 2, 77-88(1956). (Translated from Referat. Zhur. Fiz. No. 1, 1958, Abstract No. 576)

Using a counter telescope at the geomagnetic latitudes 51 and 31°N, a measurement was made of the intensity of $\mu$ mesons with kinetic energy $< 6 \times 10^8$ ev up to altitudes of 25 km. Also measured was the altitude variation of the difference in the number of $\mu$ mesons with energies $> 6 \times 10^8$ ev, traveling vertically and at an angle of 60° to the vertical. These data were used to obtain the energy spectrum of generation of new mesons in the stratosphere. At 31°N, the spectrum of the generation of new mesons with total energy $E > 7\mu c^2$ is of the form $C^{31} = 190/E^{2.6}$ min$^{-1}$ cm$^{-2}$ sterad$^{-1}$ $(\mu c^2)^{-1}$; in this case, there are generated over the entire depth of the atmosphere 5.4 mesons min$^{-1}$ cm$^{-2}$ sterad$^{-1}$ with $E > 7\ c^2$. At a latitude of 51° N, the generation spectrum is of the form: $C_1^{51} = 100/E^{2.3}$ min$^{-1}$ cm$^{-2}$ sterad$^{-1}$ $(\mu c^2)^{-1}$ for $1.9 < E \ll 7$. Another spectrum obtained is $C_2^{51} = 190/E^{2.6}$ min$^{-1}$ cm$^{-2}$ sterad$^{-1}$ $(\mu c^2)^{-1}$ for $E > 7$; in this case there are generated over the entire depth 74 new mesons min$^{-1}$ cm$^{-2}$ sterad$^{-1}$ with $E > 1.9\ \mu c$.

**17489**

INTERACTION OF COSMIC RAY PARTICLES WITH VARIOUS TYPES OF NUCLEI. N. L. Grigorov, A. V. Podgurskaya, A. I. Savel'eva, and L. M. Poperekova. Zhur. Eksptl'. i Teoret. Fiz. 35, 3-15(1958) July. (In Russian)

The transition effect of stars and single heavily ionizing particles produced in photographic plates at altitudes of 9 and 20 km was studied under various types of filters. The experimental data indicate that the number of particles in stars and the mean disintegration energy of the stars is proportional to $A^{1/3}$. Due to constancy of the flux of heavily ionizing particles and of their spectrum in air and lead it was possible to analyze previously obtained results on $\pi^0$-meson production in air and lead. It is shown that the mean energy carried off by $\pi^0$ mesons produced in the interaction of $\sim 10^{10}$ ev primary cosmic ray particles with nuclei is proportional to the radius of the target nucleus. (tr-auth)

**17490**

ON THE NATURE OF THE PARTICLES WHICH CARRY AWAY MOST OF THE ENERGY IN INTERMEDIATE ENERGY NUCLEAR COLLISIONS. E. Fridlender and E. R. Rukenshtein (Inst. of Nuclear Physics, Academy of Sciences, Rumanian Popular Republic). Zhur. Eksptl'. i Teoret. Fiz. 35, 104-10(1958) July. (In Russian)

The electron-nuclear shower transition curve in a dense absorber is computed by assuming the existence of an energetically preferred particle in each step of the nuclear-cascade process. The fraction of decaying particles in the generating component is estimated by comparing this curve with the absorption in air. (tr-auth)

**17491**

ON THE CASCADE THEORY OF SHOWERS. I. P. Ivanenko (Moscow State Univ.). Zhur. Eksptl'. i Teoret. Fiz. 35, 132-6(1958) July. (In Russian)

The equation for the average number of particles created in a layer of finite thickness and possessing energies exceeding some given value were solved with account of collision losses. The solutions obtained are compared with those of the usual cascade theory. An expression was obtained for the mean energy of particles in cascade shower at any stage of its development. (tr-auth)

**17492**

CALCULATIONS OF SHOWER-FORMING PARTICLE ENERGIES CONSIDERING THEIR ENERGY SPECTRA. Zh. S. Takibaev (Inst. of Nuclear Physics, Academy of Sciences, USSR). Zhur. Eksptl'. i Teoret. Fiz. 35, 277-9(1958) July. (In Russian)

Energies of shower-forming particles were calculated without using any of the multiple meson formation theories. (R.V.J.)

**17493**

ON THE EFFECTS OF MULTIPLE SCATTERING ON

THE DEVELOPMENT OF HIGH-ENERGY ELECTRON-PHOTON SHOWERS IN LEAD. T. G. Volkonskaya, I. P. Ivanenko, and G. A. Timofeev (Moscow State Univ.). Zhur. Eksptl'. i Teoret. Fiz. 35, 293-4(1958) July. (In Russian)

Data are presented on the longitudinal development of 154 cascade showers from primary electrons of E = $10^{12}$ ev to two units and of 40 showers up to four t-units induced by the primary electron and photon in lead. (R.V.J.)

**17494**

INCREASE IN BAROMETRIC EFFECT WITH THE ENERGY INCREASE IN WIDE ATMOSPHERIC SHOWERS. D. D. Krasil'nikov (Yakutsk Branch of the Academy of Sciences). Zhur. Eksptl'. i Teoret. Fiz. 35, 295-6(1958) July. (In Russian)

Two series of intermittent variations in the frequency of wide atmospheric cosmic showers of various densities were recorded with Geiger-Mueller counters. The statistical analysis of the mean solar day number of showers in relation to the mean solar day variations in pressure and temperature at the observed point showed a considerable increase in barometric coefficient with the increase in mean particle density ($\rho$). (R.V.J.)

**17495**

STUDIES OF FAST DEUTERONS AT THE 3200 m ALTITUDE. G. V. Badalyan (Inst. of Physics, Armenian SSR). Zhur. Eksptl'. i Teoret. Fiz. 35, 303-5(1958) July. (In Russian)

An improved magnetic spectrometer coupled with two large-multiplate Wilson chambers was used in the investigation of cosmic radiation deuterons at 3200 m altitude. Deuterons were identified by the pulse measured in the magnetic spectrometer and by the ionization track in the lower portion of the chamber. The new installation permitted the separation of ionized particle from non-ionized and the observation of particle track and the incidents of local generation of particles in the chamber material. (R.V.J.)

**17496**

SCANDIUM-45 AS THE REACTION PRODUCT OF COSMIC RADIATION IN IRON METEORITES. I. H. Wänke (Max-Planck-Institut für Chemie, Mainz). Z. Naturforsch. 13a, 645-9(1958) Aug. (In German)

By means of neutron activation analysis, the scandium content of three iron meteorites were measured. The amount of scandium found is approximately $10^{-9}$ g Sc/g and was shown to be proportional to the $He^3$, $He^4$, and Ne formed by cosmic radiation. Therefore the conclusion could be drawn that this quantity of scandium was formed for the most part by the effect of cosmic radiation on the atomic nuclei of the meteorite. The absolute concentration of scandium was compared with the reaction products of cosmic radiation previously measured in meteorites. The scandium content of a stone meteorite (Pultusk) was measured using the same methods. The value found of $5 \times 10^{-6}$ g Sc/g agrees well with other measurements made in stone meteorites. (tr-auth)

## Crystallography and Crystal Structure

**17497** ANL-5902

Argonne National Lab., Lemont, Ill.

EFFICIENCIES AND PHOTOFRACTIONS FOR GAMMA RADIATION ON SODIUM IODIDE (THALLIUM ACTIVATED) CRYSTALS. W. F. Miller, John Reynolds, and William J. Snow. Aug. 1958. 17p. Contract W-31-109-eng-38. $0.75(OTS).

The efficiencies and photofractions for monoenergetic gamma rays incident on sodium iodide (thallium activated) crystals have been calculated by the Monte Carlo method. The calculations have been carried out for broad parallel-beam sources, point sources on the crystal axis, and disk sources, all for photon energies of 0.279, 0.661, 1.33, 2.62, and 4.45 Mev. The crystals considered were right circular cylinders with radii of 1.0, 2.0, 4.0, 8.0, 12.0, and 16.0 inches, and for each radius, heights of 1.0, 2.0, 4.0, and 8.0 inches. The effect of the escape of annihilation gammas from the crystal was taken into account in the Monte Carlo calculation; however, no correction was made for escape of bremsstrahlung from secondary electrons and positrons. This latter correction is of importance only at the largest energies and for the smallest crystals where it affects the photofractions by a few per cent. (auth)

**17498**

THE CRYSTAL STRUCTURES OF $\beta$-$K_2SO_4$ AND OF $\beta$-$K_2PO_3F$. Mark T. Robinson (Oak Ridge National Lab., Tenn.) J. Phys. Chem. 62, 925-8(1958) Aug.

The crystal structures of the room temperature forms of $K_2SO_4$ and of $K_2PO_3F$ have been investigated by single-crystal x-ray diffraction studies. Both compounds are orthorhombic, belonging to space group Pnam ($D_{2h}^{16}$). The $SO_4^=$ ion is tetrahedral, but the $PO_3F^=$ ion appears to be slightly distorted and is probably disoriented in the crystal. (auth)

**17499**

ELECTRON DIFFRACTION STUDIES OF CRYSTAL STRUCTURE OF OXIDES OF IRON. A. Pande (National Physical Lab., New Delhi, India). J. Sci. Ind. Research (India) 17B, 205-8(1958) June.

The crystal structure of oxide films formed on the surface of pure iron heated to different temperatures has been analyzed by the electron diffraction method. The effect of occluded hydrogen on the formation and orientation of oxides on the metal surface has also been studied by the same technique. The discrepancy in the value of the lattice parameters as determined by the electron diffraction and X-ray diffraction methods has been satisfactorily explained as primarily due to refraction of the electron beam reflected by the microcrystals of the oxides of iron. (auth)

**17500**

ELASTIC CONSTANTS OF SILVER AND GOLD. J. R. Neighbours and G. A. Alers (Ford Motor Co., Dearborn, Mich.). Phys. Rev. 111, 707-12(1958) Aug. 1.

The three elastic constants $C_{44}$, $\frac{1}{2}(C_{11}-C_{12})$ and $\frac{1}{2}(C_{11}+C_{12}+2C_{44})$ were directly measured for silver and gold in the temperature range 4.2 and 300°K. The various contributions to the values of the 0°K constants are analyzed in terms of a simple model which quite successfully describes copper. It is concluded that such a model is unsatisfactory when applied to the heavier noble metals because these appear to have large noncentral forces contributing to their constants. Combined with pressure data the present results show the elastic constants to be explicit functions of temperature. The Debye characteristic temperatures calculated from the 0°K elastic constants are shown to be in substantial agreement with the results from calorimetry. (auth.)

**17501**

PRESSURE DERIVATIVES OF THE ELASTIC CONSTANTS OF COPPER, SILVER, AND GOLD TO 10,000 BARS. W. B. Daniels and Charles S. Smith (Case Inst. of Tech., Cleveland). Phys. Rev. 111, 713-21(1958) Aug. 1.

The pressure derivatives of the elastic constants of the

homologous series of metals, copper, silver, and gold were were measured over the pressure range from 0 to 10,000 bars, using a modified ultrasonic pulse-echo method. Means were devised to measure the change of elastic constant with pressure as directly as possible. The values found for the pressure derivatives of the elastic constants are given. The notation $C = C_{44}$, $C' = (C_{11} - C_{12})/2$, and $B_s = (C_{11} + 2C_{12})_s/3$ was used. The data for each metal, of the three elastic constants and their pressure derivatives, were interpreted in terms of conventional theory. The theoretical contributions of long-range interactions were subtracted off and the remainder attributed to short-range nearest-neighbor interaction. The analysis indicates that these must be noncentral, many-body interactions in order to account for the shear constants and especially their pressure derivatives. The many-body character of the interactions is of rapidly increasing importance in the sequence copper, silver, and gold. (auth.)

**17502**

OXYGEN BAND IN MAGNESIUM OXIDE. Jiro Yamashita (Univ. of Illinois, Urbana). Phys. Rev. 111, 733-5(1958) Aug. 1.

The approximation of tight binding is employed to determine the width and the depth of the oxygen band in MgO. A width of about 9 ev and a depth of about 7.6 ev are obtained. The agreement between theory and experiment seems to be fairly good. (auth.)

**17503**

SOME EXPERIMENTS ON THE MOTION OF 180° DOMAIN WALLS IN $BaTiO_3$. Robert C. Miller (Bell Telephone Labs., Murray Hill, N. J.). Phys. Rev. 111, 736-9(1958) Aug. 1.

Single-crystal $BaTiO_3$ samples with aqueous LiCl electrodes in place of the customary noble metal electrodes are observed to undergo polarization reversal with electric fields of several hundreds of volts per cm in a manner very much analogous to certain ferromagnetic materials. It is shown for the first time that polarization reversal in $BaTiO_3$ can take place by the expansion of a few domains through extensive sideways 180° domain wall motion. The observed domain configurations show that the smallest switched domains are probably circular in cross section and do not appear to go through the thickness direction of the crystal. The small domains grow through sideways 180° domain wall motion into large ones which have approximately square cross sections with the straight sides at 45° to the a axes. It is also noted that few, and sometimes no, ferroelectric Barkhausen pulses are observed during polarization reversal, and that Barkhausen pulses can occur when two switched domains come together. (auth)

**17504**

NORMAL MODES OF GERMANIUM BY NEUTRON SPECTROMETRY. B. N. Brockhouse and P. K. Iyengar (Atomic Energy of Canada Ltd., Chalk River, Ont.). Phys. Rev. 111, 747-54(1958) Aug. 1.

The frequency wave-number relations of the lattice vibrations in germanium which propagate in the symmetric [100] and [111] directions were obtained by studying energy distributions of neutrons scattered by a germanium single crystal. The characters of the phonons were ascertained from the intensities and positions of the neutron groups in the reciprocal lattice. The methods are discussed. The results cannot be fitted by simple models using the Born-von Kármán theory, but explain satisfactorily the specific heat. The far-infrared spectrum of germanium can be interpreted as combination bands in terms of the results. (auth.)

**17505**

CATHODOLUMINESCENCE OF STRONTIUM OXIDE, BARIUM-STRONTIUM OXIDE, AND MAGNESIUM OXIDE. H. W. Gandy (Univ. of Missouri, Columbia). Phys. Rev. 111, 764-71(1958) Aug. 1.

A survey of some spectral and time decay properties of the cathodoluminescence of SrO, (BaSr)O, and MgO samples was made in sealed-off high-vacuum tubes in the spectral range from 220 to 600 mμ. Observations were made for sample temperatures varying from 90°K to room temperature and above with the samples in different states of thermionic activity. In SrO samples, luminescence maxima were observed at photon energies of 4.9, 3.7, 3.2, and 2.4 ev. The 4.9-ev band intensity increases with the thermionic activity of the sample whereas that of the 3.2-ev band decreases. Emission band maxima were found in (BaSr)O at energies of 4.0, 3.1, 2.6, and 2.1 ev. A comparison of the (BaSr)O luminescence is made with that from SrO and BaO. MgO samples were studied in both polycrystalline and single crystal forms. Luminescence band maxima were observed at energies of 5.2, 3.6, 2.7, 2.3, and 2.1 ev. The 2.3-ev band may be enhanced by heating the sample in magnesium vapor or diminished by heating it in oxygen. Suggestions are made concerning possible electronic mechanisms giving rise to some of the above bands on the basis of the temperature dependence of their intensities and their types of afterglow. (auth.)

**17506**

MULTISPIN AXIS STRUCTURES FOR ANTIFERROMAGNETS. W. L. Roth (General Electric Research Lab., Schenectady, N. Y.). Phys. Rev. 111, 772-81(1958) Aug. 1.

Neutron diffraction intensities were computed for antiferromagnetic spin arrangements in the rock-salt-type structure. If the spin directions in the unit cell occur at relative angles other than 0 or 180°, the neutron scattering from powder specimens does not lead to a unique solution of the spin arrangement. A unique solution can be obtained from neutron scattering by a single-domain crystal. Neutron diffraction from crystals of nickel oxide shows that in all crystals examined, either the magnetic moments were parallel to more than one direction in the crystal, or antiferromagnetic domains were present. The results can be quantitatively accounted for by assuming the crystal consisted of domains with a common magnetic axis. (auth)

**17507**

BAND STRUCTURE AND INFRARED ABSORPTION OF GRAPHITE. W. S. Boyle and P. Nozières (Bell Telephone Labs., Murray Hill, N. J.). Phys. Rev. 111, 782-5(1958) Aug. 1.

The infrared optical properties of graphite single crystals have been calculated from a model of the band structure developed by group theory. These calculations have been compared with measurements of the emissivity and reflection coefficient of single crystals. At short wavelengths interband effects predominate; from the experimental results the maximum splitting of the $\pi$ bands at a corner of the zone has been set at 0.56 electron volt. At longer wavelengths the intraband contributions become large, giving rise to plasma effects in the neighborhood of 25 microns. This gives an approximate value of the band overlap lying between 0.04 and 0.01 electron volt. (auth)

**17508**

PARAMAGNETIC RESONANCE SPECTRUM OF COBALT IN CERIUM MAGNESIUM NITRATE AT 4°K. W. B. Gager, P. S. Jastram, and J. G. Daunt (Ohio State Univ., Columbus). Phys. Rev. 111, 803-9(1958) Aug. 1.

Paramagnetic resonance spectra of cobalt in crystals containing cerium and bismuth magnesium nitrate were studied at 4°K for various cerium-bismuth ratios. It is found that the cobalt hyperfine spectrum, well resolved in pure bismuth magnesium nitrate, is strongly attenuated by the addition of small percentages of cerium. For ionic cerium concentrations higher than 20% of the cerium-bismuth total, the cobalt hyperfine components cannot be resolved at all, except for the particular case of a 50% mixture. The attenuation of the cobalt spectrum is attributed to magnetic dipole interactions with the cerium ion, and it is suggested that this may also account for the fact that the observed degree of Gorter-Rose orientation of $Co^{60}$ in cerium magnesium nitrate disagrees with the results of calculations that do not include the effect of dipole-dipole interactions. (auth)

**17509**

THEORY OF LINE NARROWING BY DOUBLE-FREQUENCY IRRADIATION. F. Bloch (Stanford Univ., Calif.). Phys. Rev. 111, 841-53(1958) Aug. 1.

Starting from the general equation for the distribution matrix, magnetic resonance absorption in crystals is treated by introducing the Fourier transform of the resonance line which is shown to have the convenient form of a simple trace. The method is first applied to rederive some earlier results of Van Vleck, concerning the moments of the line. It is then extended to include the case of the following experimental paper, where resonance absorption of one magnetic ingredient is observed while another magnetic ingredient is at the same time subjected to a strong resonant rf field. It is shown that the absorption line exhibits a center line and faint sidebands, and formulas for the intensity and shape of these lines are developed. In particular, it is shown that the total second moment of the absorption is unaltered by irradiation of the other ingredient. A quantitative measure for the observed narrowing of the center line is found through the reduction of its second moment, which is compensated by the contribution of the sidebands to the total second moment. (auth)

**17510**

DOUBLE NUCLEAR MAGNETIC RESONANCE AND THE DIPOLE INTERACTION IN SOLIDS. L. R. Sarles and R. M. Cotts (Stanford Univ., Calif.). Phys. Rev. 111, 853-9(1958) Aug. 1.

The nuclear magnetic dipole interactions in a polycrystalline sample of sodium fluoride were investigated using an extension of the magnetic resonance technique. The resonance absorption of $Na^{23}$ was observed with a variable-frequency spectrometer in a fixed external magnetic field, and the mean square width of the line shape computed. This width has two main sources: (a) the interaction of $Na^{23}$ nuclei with other $Na^{23}$ nuclei through the dipole fields of the magnetic moments, and (b) the interaction of $Na^{23}$ nuclei with neighboring $F^{19}$ nuclei by the same mechanism. The application of a strong rf field satisfying the resonance condition for $F^{19}$ nuclei in the same external field caused rapid transitions between the fluorine Zeeman energy levels, and thus altered the average field produced at the position of sodium nuclei by the nuclear magnetic moments of fluorine. By varying the strength of this rf field and also by varying the deviation from precise resonance of the $F^{19}$ spins, one could selectively alter the contributions of this source of line broadening. The available rf field was not sufficiently intense to eliminate entirely the broadening caused by source (b). However, the detailed behavior of this contribution to the width as a function of the deviation from resonance agrees well with a theory of Bloch for the case of the rf field strong compared to the line widths involved. (auth)

**17511**

CRYSTAL STRUCTURE AND FERRIMAGNETISM IN $NiMnO_3$ AND $CoMnO_3$. W. H. Cloud (E. I. du Pont de Nemours and Co., Wilmington, Del.). Phys. Rev. 111, 1046-9(1958) Aug. 15.

X-ray diffraction studies of individual crystals of $NiMnO_3$ show that these compounds have the structure of ilmenite (space group $R\bar{3}$). The crystals have a platelike crystal habit with the threefold symmetry axis perpendicular to the faces of the platelet. Positions of atoms within the unit cell were determined by comparing calculated structure factors with those obtained from x-ray powder patterns. There are two Ni-O-Mn configurations that appear to be favorable to a magnetic supercharge interaction, and these are sufficient to extend magnetic ordering in three dimensions. (auth)

**17512**

OPTICAL PROPERTIES OF CRYSTALLINE BORON. W. G. Spitzer and W. Kaiser (Bell Telephone Labs., Murray Hill, N. J.). Phys. Rev. Letters 1, 230-2(1958) Oct. 1.

The absorption and reflectivity of high-purity boron were studied. The carrier concentrations were approximately $10^{13}$ $cm^{-3}$ and the wavelengths ranged between 0.7 and 30 $\mu$. The specimens were of the rhombohedral type with 107 or 108 atoms per unit cell. (W.D.M.)

**17513**

MAGNETOACOUSTIC RESONANCE IN YTTRIUM IRON GARNET. E. G. Spencer and R. C. LeCraw (Bell Telephone Labs., Murray Hill, N. J.). Phys. Rev. Letters 1, 241-3(1958) Oct. 1.

Polished spheres of single-crystal yttrium iron garnet were observed to resonate acoustically in the 5 to 30-Mc/sec region by applying a 9300 or a 3000-Mc/sec electromagnetic signal under proper conditions. The ferromagnetic line width of the samples used was 0.5 oe. Observations and conclusions are presented. (W.D.M.)

## Electrical Discharge

**17514** ARL-57-1026

Ramo-Wooldridge Corp. Aeronautical Research Lab., Los Angeles.

CONFINEMENT OF A PLASMA COLUMN BY RADIATION PRESSURE AND ITS APPLICATION TO FUSION POWER GENERATION. Erich S. Weibel. Aug. 26, 1957. 64p.

A detailed analysis of various aspects of plasma containment by radiation pressure is presented. Plasma reflectivity allows application of radiation pressure. It does not depend on drift. A toroidal cavity configuration looks promising, the radiation consisting of a longitudinal electric and a transverse magnetic field. (T.R.H.)

**17515** NP-5448(4th Ed.)

Massachusetts Inst. of Tech., Cambridge. Research Lab. of Electronics.

BASIC DATA OF ELECTRICAL DISCHARGES. Technical Report 283. Fourth Edition. Sanborn C. Brown and W. P. Allis. June 9, 1958. 197p. Project No. 3-99-00-100. Contract DA36-039-sc-64637.

Data in the form of tables and graphs are presented on excitation and ionization potentials of atoms, collision probabilities, surface phenomena such as secondary emission, motions of electrons and ions, production

and decay of ionization, voltage breakdown, electron energy loss, and discharge characteristics. Formulas and definitions are also included. (D.E.B.)

**17516** UCRL-4595(Rev.)

California. Univ., Livermore. Radiation Lab. PROJECTION OF PLASMA ACROSS A MAGNETIC FIELD. W. H. Bostick, D. R. Lasher, David Finkelstein, and V. G. McIntosh. Nov. 10, 1955. Decl. June 8, 1956. 28p. Contract W-7405-eng-48. $4.80(ph OTS); $2.70 (mf OTS).

A blob of plasma projected from a source can be observed to proceed across a magnetic field. Probe measurements show that this plasma is electrically polarized, both laterally and in the direction of motion of the blob. Magnetic-pickup-loop measurements show the blob to be diamagnetic. Photographs of the trajectories of the blobs in their recombination-light show that they can be either elastically scattered from one another, or can react to form a compound entity which appears to have a toroidal structure. It is believed that these blobs are actually stable configurations of plasma and magnetic field, having both diamagnetic moment and spin. (auth)

**17517** AEC-tr-3161

STABILITY OF A PLASMA. (Zur Stabilität eines Plasmas). K. Hain, R. Lüst, and A. Schlüter. Translated from Z. Naturforsch. 12a, 833-41(1957). 13p.

It is shown that the stability of hydromagnetic equilibrium as studied by the method of small perturbations is controlled by one differential equation of second order in time, if one neglects viscosity, electrical resistivity, and thermal conductivity. Since the differential equation is self-adjoint, some general theorems can be derived which hold for all configurations of hydromagnetic equilibrium. It is possible to show that the rates of growing are limited under certain conditions. Also some sufficient conditions of stability can be given. For a plasma cylinder, inside of which the magnetic field vanishes, the differential equations are solved explicitly and conditions for stability are given. Finally it is shown that the differential equation is also self-adjoint if the pressure is not isotropic. (auth)

**17518**

PROPERTIES OF AN IONIZED GAS OF LOW DENSITY IN A MAGNETIC FIELD. PART IV. S. Chandrasekhar, A. N. Kaufman, and K. M. Watson (Los Alamos Scientific Lab., N. Mex.). Ann. Phys. (N. Y.) 5, 1-25(1958) Sept.

A systematic method is described for solving the Boltzmann equation for the steady states of an ionized gas of low density in a strong magnetic field. On the assumption that the term representing the Lorentz force in the Boltzmann equation dominates all others, the solution is developed as a series in inverse powers of the gyration frequency $\omega$. The solution is explicitly carried out to the first order in $\omega^{-1}$. Expressions for the drifts which arise in the first order are also obtained. (auth)

**17519**

DYNAMIC STABILITY OF A SELF-PINCHED DISCHARGE. H. W. Wyld, Jr. (Ramo-Wooldridge Corp., Los Angeles). J. Appl. Phys. 29, 1460-5(1958) Oct.

The stability of a rapidly contracting self-pinched discharge (fast pinch effect) is studied using three different models for the plasma dynamics: (a) the free particle model; (b) the snowplow model; (c) the shock wave model. For each model the growth in time of a small perturbation on a time-dependent unperturbed solution of the equations of motion is obtained. It is shown that the free particle model and the shock wave model predict instabilities. The instabilities are rather mild, the instability times being of the order of the pinch time itself. The snowplow model predicts stability for the initial stages of the pinch, although instabilities probably develop later on. (auth)

**17520**

PLASMA JET THRUST UP; A SPACE MILESTONE. Raymond M. Nolan. Missiles and Rockets 4, No. 13, 11, 30(1958) Sept. 29.

A brief review of plasma jets is presented, and the possibility of using them for satellite or space vehicle attitude control is considered. Attitude control requires little more power than is now planned for TV scanning satellites. (W.D.M.)

**17521**

FUSION: THE RUSSIAN PICTURE. Nucleonics 16, No. 9, 23-4(1958) Sept.

The Russian program on fusion research revealed at Geneva is a large and comprehensive one, with research in the fast pinch, stabilized pinch, and plasma traps. A description was given of the ORGA, which is roughly similar to the DCX device. Theoretical considerations on fusion have led the Russians to a detailed theory of radiation losses from hot plasma. (J.S.R.)

**17522**

FUSION. Nucleonics 16, No. 9, 66-9, 144(1958) Sept.

The U. S. papers presented at Geneva on fusion show a diversity of approach. The highlights of the Project Sherwood program are the DCX, Pyrotron, and Stellerator devices, the Los Alamos experiments, and the conception of the Astron by N. C. Christofilos. (J.S.R.)

**17523**

A DIELECTRIC FORMULATION OF THE MANY BODY PROBLEM: APPLICATION TO THE FREE ELECTRON GAS. P. Nozières and D. Pines (Laboratoire de Physique, Ecole Normale Superieure, Paris). Nuovo cimento (10) 9, 470-90(1958) Aug. 1.

Under suitable conditions it is shown that a generalized dielectric constant $\epsilon(k, \Omega)$ for an arbitrary many-body problem may be defined by analogy with the macroscopic laws of electrostatics. The ground state energy may then be simply expressed in terms of $\epsilon(k, \Omega)$ without resort to perturbation theoretic expansions. Within the random phase approximation (RPA), $\epsilon(k, \Omega) = 1 + 4\pi\alpha(k, \Omega)$, where $\alpha(k, \Omega)$ is the complex polarizability obtained by a generalized Kramers-Heisenberg formula in the plane wave representation. For the free electron gas, this value of $\epsilon(k, \Omega)$ leads directly to the expression for the ground state energy obtained by Gell-Mann and Brueckner and by Hubbard in the high density limit. It is shown that the treatment of electron interaction within the RPA is equivalent to taking into account only the field of surface charges at the external boundary of the system; it thus corresponds to neglecting all potential and local field corrections. $\epsilon(k, \Omega)$ may be inferred from the inelastic scattering of fast electrons or from the Compton scattering of x rays; the circumstances are discussed under which such experiments yield information about the ground state energy of the electron gas. (auth)

**17524**

FUSION CHAIN REACTION. CHAIN REACTION WITH CHARGED PARTICLES. Michal Gryziński (Warsaw Univ. and Inst. of Nuclear Research, Warsaw). Phys. Rev. 111, 900-5(1958) Aug. 1.

It is shown that in the case of a medium which is an exoergic nuclear mixture ( a mixture of nuclei which can lead to an exoenergetic reaction) and which possesses a high temperature ($\sim 10^7$ °K) or a relatively

high density ($\sim 10^4$ g/cc), a fusion chain reaction can take place. This is due to the decrease in the stopping power of the medium under the conditions given above. Equations for determining the multiplication factor for a binary mixture under various physical conditions are derived. The multiplication factor is calculated for a DT mixture. It is concluded that for an exoergic nuclear mixture there exists a critical temperature or a critical density which limits the slow release of fusion nuclear energy. For an infinite medium of 50% DT mixture the critical temperature and the critical density are $\sim 10^7$ °K and $\sim 10^3$ g/cc, respectively. In a finite medium the values are higher and there exists a critical mass which limits the possibility for the development of a fusion chain reaction. This critical mass was estimated and in first approximation is $m_{cr}$ (in grams) = 1/(density of the medium in g/cc)$^2$. (auth)

**17525**

THEORY OF THE CATHODE SHEATH IN A LOW-DENSITY GAS DISCHARGE. P. L. Auer, H. Hurwitz, Jr., and S. Tamor (General Electric Research Lab., Schenectady, N. Y.). Phys. Rev. 111, 1017-28(1958) Aug. 15.

The space-charge equations of a low-density gas discharge are derived and applied to the study of potential distributions in the cathode sheath. In order to facilitate mathematical computation, the contribution of secondary electrons and charge exchange to the potential distribution is neglected. The space charge is generated, consequently, by the primary electrons of the hot cathode and the ions resulting from volume ionization of the gas in the sheath. The effect of arbitrary positive-ion currents issuing from the positive column to the sheath is also examined. A self-consistent method of solution of the space-charge equations is employed. The method essentially involves finding a cross section which corresponds to a particular potential distribution. A number of cross sections of physical significance can be obtained by this method. The results of our numerical calculations allow us to draw certain semi-quantitative conclusions about the mode of evolution of a cathode sheath and positive column with increasing gas pressure and applied voltage. An important conclusion of our calculations is that a positive column will begin to evolve when the number of ionization mean free paths in the discharge gap is of the same order as the square root of the ratio of electron to positive-ion mass. (auth)

**17526**

POSSIBLE HYDROMAGNETIC SIMULATION OF COSMICAL PHENOMENA IN THE LABORATORY. Winston H. Bostick (Stevens Inst. of Tech., Hoboken, N. J.). Revs. Modern Phys. 30, 1090-4(1958) July.

A technique has been developed whereby ionized gas (plasma) can be projected, by magnetic forces, at speeds of $3 \times 10^7$ cm/sec through a vacuum region free from a magnetic field. The plasma has also been projected across magnetic fields in vacuum at speeds of $10^7$ cm/sec. It is concluded that magnetohydrodynamic phenomena are being produced in the laboratory. (W.D.M.)

**17527**

POSSIBILITY OF CREATING THERMONUCLEAR REACTIONS IN A GAS DISCHARGE. L. V. Kurchatov. Uspekhi Fiz. Nauk 59, No. 4, 603-18(1956). (Translated from Referat. Zhur. Fiz. No. 5, 1957, Abstract No. 11249.)

**17528**

X-RAY FLASH INVESTIGATION ON SPARK COLLISION WAVES IN GASES. Karl-Heinz Herrmann. Z. angew Phys. 10, 349-56(1958) Aug. (In German)

A description is given of the apparatus used to obtain x-ray flash pictures of spark collision waves in argon, carbon dioxide, and air. The density distribution in the vicinity of the spark at varying times was obtained, and the collision wave velocity was measured. A determination of the dynamic pressure which appears in the collision wave was also made. (J.S.R.)

**17529**

INVESTIGATION ON SHORT ALTERNATING CURRENT ARCS IN AIR. Part II. Heinz Nöske (Siemens-Schuckertwerke A. G., Berlin-Siemensstadt). Z. angew. Phys. 10, 382-93(1958) Aug. (In German)

The results from slow-motion photography of short alternating current arcs in air are given, and the results are discussed theoretically. (J.S.R.)

**17530**

SELFCONTRACTING DISCHARGES IN DEUTERIUM AT HIGH VELOCITY GROWING CURRENTS. V. S. Komelkov. Zhur. Eksptl'. i Teoret. Fiz. 35, 16-26 (1958) July. (In Russian)

Results of an investigation of selfcontracting discharges involving rates of current growth of $7 \times 10^{11}$ and $1.4 \times 10^{12}$ amp/sec and current amplitudes up to $2 \times 10^6$ amp are described. The initial pressure of the deuterium in the chambers was varied from 0.1 to 10 mm Hg. The highest temperature in the gas which was possibly attained was about 200 ev. (tr-auth)

**17531**

OBSERVATION OF THE PINCH-EFFECT DURING DECREASE OF THE CURRENTS. V. L. Granovskii, K. P. Ryumina, V. I. Savoskin, and G. G. Timofeeva (All-Union Electrotechnical Inst.). Zhur. Eksptl'. i Teoret. Fiz. 35, 45-9(1958) July. (In Russian)

An image converter tube was used to photograph the instantaneous state of the arc plasma in $H_2$ and Hg at $p = 10^{-3}$ to $10^{-2}$ mm Hg, current pulses of 1.3 to 5.5 ka and current pulse durations up to 300 $\mu$sec. It was found that electrodynamical deformation (compression and bending) of the arc column exists for values $di/dt < 0$. Their disappearance (straightening and compression of the column) commences at points of high gas density (near the anode or cathode depending on the conditions of the experiment). (tr-auth)

**17532**

PROPAGATION OF DETONATION WAVES IN THE PRESENCE OF A MAGNETIC FIELD. E. Larish and I. Shekhtman. Zhur. Eksptl'. i Teoret. Fiz. 35, 203-7 (1958) July. (In Russian)

It is shown that relativistic detonation waves in a magnetic field possess properties which are similar to those of the ordinary waves. Solutions of the equations at the discontinuity are presented for the relativistic and nonrelativistic cases. (tr-auth)

## Electrons

**17533**

THE MAGNETIC MOMENT OF THE ELECTRON. Charles M. Sommerfield (Univ. of California, Berkeley). Ann. Phys. (N. Y.) 5, 26-57(1958) Sept.

The spin magnetic dipole moment of the electron is computed to fourth order in perturbation theory. The procedure is to consider a system of one electron moving in a constant external magnetic field. The Green's function and mass operator for the electron are computed as functions of this field. The expectation value of the mass operator is the self-energy of all the electron and the magnetic moment is identified from that

part of the self-energy linear in the external field. The techniques used are illustrated in a calculation of the second-order moment. The derivation of the fourth-order moment is sketched. It is found to be $\mu^4 = -0.328\ (\alpha/\pi)^2$ in Bohr magnetons, where $\alpha$ is the fine-structure constant. This differs from the result of a previous calculation. (auth)

**17534**

THE POLARIZATION OF ELECTRONS. Klaus-Werner Hoffmann (Univ. of Göttingen, Germany). Naturwissenschaften 45, 377-81(1958). (In German)

A survey is presented on the production of transverse polarized electrons, detection of transverse polarized electrons, experimental confirmation of polarization by scattering, behavior of polarization in fields, longitudinal polarization of electrons in $\beta$ decay, experiments for the investigation of polarization in $\beta$ decay, and polarization of positrons. 36 references. (J.S.R.)

**17535**

MEASUREMENT OF LONGITUDINAL POLARIZATION OF ELECTRONS EMITTED IN $\beta$-DECAY. A. I. Alikhanov, G. P. Eliseiev, and V. A. Liubimov (USSR Academy of Sciences, Moscow). Nuclear Phys. 7, 655-71(1958) Aug.

The longitudinal polarization of Coulomb $\beta$-transition electrons was measured for several electron energies. The polarization value was found to be equal to $-v/c$ for all the substances measured. It is proved that the most probable relationships among the coupling constants in $\beta$-decay are $C_T = -C'_T$, $C_S = -C'_S$, $C_V = C'_V$, $C_A = C'_A$. (auth)

**17536**

THE SUPPRESSION EFFECT IN IONIZATION BY FAST ELECTRON PAIRS. G. H. Burkhardt (Univ. of Birmingham, Eng.). Nuovo cimento (10) 9, 375-99(1958) Aug. 1.

Electron pairs of very high energies (about $10^{11}$ ev) were found by Perkins to have reduced ionizing power near their origin. The reason is that the angle between the two paths is so small that over appreciable distances they stay close enough to partially cancel their electric fields except for atoms very close to the line of travel. A quantum treatment of this effect is given and the deviations from the semi-classical result are found negligible, in spite of the fact that the general conditions for the validity of classical mechanics are not satisfied. The phenomenon can be used to estimate the energy of the pair. The limitations of this method, both fundamental and practical, are discussed. (auth)

**17537**

INFLUENCE OF THE LATTICE POTENTIAL AND CONTRIBUTION OF THE SHELLS TO POSITRON ANNIHILATION IN COPPER. E. Daniel (Physique des Solides, Sorbonne, Paris). Phys. and Chem. Solids 8, 205-12 (1958) Aug.

Positron annihilation in copper is investigated, taking into account the periodic potential of the lattice. It is found that annihilation with the conduction electrons takes place practically as if the positron were free with its ordinary mass. The contribution to annihilation due to d electrons in copper is also evaluated; this term is relatively small, but the only one able to explain the tails with large momenta of the experimental curves deduced from $\gamma$-ray angular correlations. Collisions between electrons and the thermalized positron do not broaden the energy levels much. All these results justify the approximations made in a preceding article. (auth)

**17538**

KINETIC EJECTION OF ELECTRONS FROM TUNGSTEN BY CESIUM AND LITHIUM IONS. Paul M. Waters (Univ. of California, Berkeley). Phys. Rev. 111, 1053-61(1958) Aug. 15.

The total yield and the kinetic-energy distribution were measured for electrons ejected from both atomically clean and gas-covered tungsten surfaces by impact of $Li^+$ and $Cs^+$ in the kinetic-energy range 150 to 1500 ev. The results indicate that the probability of kinetic emission becomes vanishingly small, $\sim 10^{-6}$, in the vicinity of 150-ev ion kinetic energy and increases to $6.2 \times 10^{-2}$ and $1.2 \times 10^{-2}$ at 1500 ev for $Li^+$ and $Cs^+$, respectively, when the tungsten surface is atomically clean. The adsorption of a monolayer of either $O_2$ or $N_2$ increases the efficiency of this process by at least an order of magnitude below 350-ev ion energy, and by a factor of 2 or 3 at energies above some 500 ev. In addition, it was observed that the energy distribution of the electrons ejected does not change significantly as the result of such adsorption. An attempt to measure the probability of formation of $Li^-$ from $Li^+$ striking an atomically clean tungsten surface showed that such a process, it if occurs at all, occurs with a probability less than about $2 \times 10^{-8}$ for $Li^+$ incident with 150- to 1500-ev kinetic energy, while negative ions of undetermined constituency were observed to be formed with a probability of about $2 \times 10^{-3}$ under the same conditions when the tungsten surface was thoroughly contaminated. (auth)

**17539**

SIGN OF THE GRAVITATION MASS OF A POSITRON. L. I. Schiff (Stanford Univ., Calif.). Phys. Rev. Letters 1, 254-5(1958) Oct. 1.

It is pointed out that the sign can be determined experimentally by reference to the work of Eötvös. In the experiment the ratio of gravitational to inertial mass was measured for several substances, and an attempt was made to detect differences in this ratio between one substance and another. No definite evidence for such differences was found. It is concluded that the Eötvös experiment precludes the possibility that the gravitational mass of a positron is equal to and opposite in sign from that of an electron. (W.D.M.)

**17540**

POLARIZATION OF INTERNAL CONVERSION ELECTRONS EMITTED AFTER $\beta$-DECAY. V. B. Berestetskii and A. P. Rudik. Zhur. Eksptl'. i Teoret. Fiz. 35, 159-64(1958) July. (In Russian)

The correlation between the polarization conversion electrons and the direction of electrons emitted in the preceding $\beta$ decay is considered. If the Coulomb field of the nucleus is neglected one finds in the case of a magnetic multipole that the polarization is longitudinal and is independent of the energy. In the case of an electric multipole longitudinal as well as transverse polarization exist which are dependent of the energy. (tr-auth)

**17541**

ELECTRON REFLECTION FROM HIGH FREQUENCY POTENTIAL BARRIER. M. A. Miller (Gor'kii State Univ.). Zhur. Eksptl'. i Teoret. Fiz. 35, 299-300(1958) July. (In Russian)

## Gases

**17542**

EFFECT OF ADSORPTION IN BARRIER SEPARATION. Karl Kammermeyer and Darrell D. Wyrick (State Univ. of Iowa City, Iowa). Ind. Eng. Chem. 50, 1309-10(1958) Sept.

The differences in adsorbability of the components of a gaseous mixture on a microporous barrier were investigated using mixtures of propane and carbon dioxide in flow through porous glass. The mixture gave appreciable enrichment in propane, the more condensable component, on the basis of absorbed flow, since the molecular weights were essentially equal. It is concluded that vapor mixtures can be separated with barriers by utilizing differences in the adsorbed flow of the components by proper adjustment of operating conditions. (J.R.D.)

**17543**

APPROXIMATE FORMULAS FOR THE VISCOSITY AND THERMAL CONDUCTIVITY OF GAS MIXTURES. Richard S. Brokaw (Lewis Flight Propulsion Lab., Cleveland). J. Chem. Phys. 29, 391-7(1958) Aug.

Approximate expressions for the viscosity and thermal conductivity of gas mixtures have been derived from the rigorous kinetic theory formulas. Three levels of approximation are distinguished, with the third approximation rigorous for binary mixtures. The first approximation for mixture viscosity is found to be very nearly equivalent to empirical expressions known heretofore. The first and second approximations for mixture conductivity have been compared with rigorous calculations for binary mixtures of nonpolar gas pairs; the first approximation has an average error of 2.6% while the second approximation reduces this error to 0.5%. The second approximation accounts for the thermal conductivity of binary mixtures of polar and nonpolar gases. (It is assumed that the interchange of translational energy is abnormal for the polar-polar interaction.) (auth)

**17544**

KINETIC THEORY OF THE IMPULSIVE MOTION OF AN INFINITE PLANE. Eugene P. Gross and E. Atlee Jackson (Brandeis Univ., Waltham, Mass.). Phys. Fluids 1, 318-28(1958) July-Aug.

The half-range method of solution of the Boltzmann equation is used to give a kinetic theory treatment of the Rayleigh problem. In contrast to the Navier-Stokes or Grad theories, the method yields exact results for the initial stress and slip velocity at the boundary. It also indicates corrections to the classical Rayleigh results, even at long times compared to the collision periods of the gas molecules. The corrections are shown to be related to the usual slip boundary conditions of hydrodynamics plus an additional part arising from boundary layer effects. The half-range method predicts corrections to the standard methods of between 10 to 25% for all values of the time. (auth)

**17545**

COMPRESSIBILITY AND INTERMOLECULAR FORCES IN GASES: METHANE. H. W. Schamp, Jr., E. A. Mason, A. C. B. Richardson, and A. Altman (Univ. of Maryland, College Park). Phys. Fluids 1, 329-37(1958) July-Aug.

The compressibility of a sample of very pure methane has been measured with high precision from 0 to 150°C and over a pressure range of about 20 to 230 atms. The precision attained is of the order of 1 part in $10^4$. Small but consistent discrepancies exist between the present results and earlier measurements, and it is believed these discrepancies are the result of a small impurity of ethane in the methane used earlier. The virial coefficients of methane are redetermined from the present measurements, and the intermolecular forces of methane are calculated from the second virial coefficient for several forms of force laws. These force laws are then used to calculate the third virial coefficient, the crystal properties at 0°K, and the viscosity for comparison with experiment. All the force laws fit the second virial coefficient very well, but some can be eliminated on the basis of the other properties. (auth)

**17546**

TRANSIENT ANALYSIS OF THE TOWNSEND DISCHARGE. Peter L. Auer (General Electric Research Lab., Schenectady, N. Y.). Phys. Rev. 111, 671-82(1958) Aug. 1.

The transient growth of currents in a one-dimensional Townsend gas discharge system under uniform d-c field conditions is examined. It is shown that a general solution for arbitrary external conditions can be given in terms of a "unit pulse" solution. Two cases are examined in detail; in one case the discharge is initiated by a single pulse from the cathode, in the second case the discharge develops under constant external illumination of the cathode. Expressions are derived which permit reasonably rapid calculation of quantities pertinent to the transient characterization of the discharge. For the two cases considered in detail, numerical illustrations are given and comparison is made with the results of other investigators. (auth.)

**17547**

ON THE FRACTIONATION OF GASEOUS SAMPLES IN A MASS SPECTROMETER VISCOUS LEAK. A. J. H. Boerboom and H. A. Tasman (Laboratorium voor Massaspectrografie, Amsterdam). Physica 24, 683-91 (1958) Aug.

Investigation was made of the fractionation in a mass spectrometer gas inlet system, consisting of a viscous leak connected to the sample reservoir by a long and narrow capillary tube. Graphs are given representing the total fractionation and the time required to approach the stationary state to a certain degree, as a function of the dimensions of the leak and the capillary. The cases treated are 1:1 mixtures of $O_2^{16}-O^{16}O^{18}$; $H_2-O_2^{16}$; and $H_2-HD$. (auth)

**17548**

AERODYNAMIC DISSIPATION. H. E. Petschek (AVCO Research Lab., Everett, Mass.). Revs. Modern Phys. 30, 966-74(1958) July.

An analysis of aerodynamic dissipation is presented for the case of a completely ionized gas in the presence of a magnetic field. The derivation of the basic flow equation is re-examined, and it is shown that the basic microscopic dissipation mechanism is appreciably different in the ionized gas. The magnitudes of various terms in the Boltzmann equation are determined so that different regions can be defined in terms of the gas state. Pulse steepening in the M region is described. The steady-state shock structure can not be defined at the present. A brief description is given of experiments studying gas dynamics in the M region. (J.S.R.)

**17549**

MAGNETOHYDRODYNAMIC DISSIPATION. L. Biermann and A. Schlüter (Max Planck Institut für Physik, Göttingen, Germany). Revs. Modern Phys. 30, 975-8 (1958) July.

Three mechanisms by which the kinetic energy of the gas of interstellar space or in the vicinity of stars may be dissipated are discussed. It is assumed that the cosmic gas is at least partly ionized and is pervaded by magnetic fields. (J.S.R.)

**17550**

COLLISION OF TWO HIGHLY IONIZED CLOUDS OF GAS. F. D. Kahn (Manchester Univ., Eng.). Revs. Modern Phys. 30, 1069-72(1958) July.

If two rarefied masses of gas collide at a sufficiently high speed, their relative motion will be stopped by a

collective plasma instability rather than by collisions of individual particles. The possible influence of magnetic fields is ignored for the most part, but a criterion is found to decide under what conditions the collective interaction remains dominant even when they cannot be ignored. (W.D.M.)

**17551**

SOME EXACT SOLUTIONS OF THE EQUATIONS OF MAGNETOHYDRODYNAMICS WHEN BOTH SELF-ATTRACTION AND MAGNETIC FIELDS ARE PRESENT. G. C. McVittie (Univ. of Illinois Observatory, Urbana). Revs. Modern Phys. 30, 1080-3(1958) July.

To the conditions of compressibility, pressure-gradient force, self-gravitation, and adiabatic motion in the large-scale dynamics of cosmical gas clouds, the effects of the presence of magnetic fields were added. The conductivity of the material is assumed to be infinite and of constant permeability. The effects of turbulence, viscosity, and heat conduction are neglected. (W.D.M.)

**17552**

SHOCK WAVES IN MAGNETOGASODYNAMIC TURBULENCE. S. A. Kaplan (Astronomical Observatory, Lvov, U.S.S.R.). Revs. Modern Phys. 30, 1089(1958) July

The conclusion drawn is that the dissipation of shock wave energy in interstellar turbulence is unimportant. (W.D.M.)

**17553**

THE BOLTZMANN EQUATION FOR GASES FROM THE PARTICLE SPIN. L. Waldmann (Max-Planck-Institut für Chemie, Mainz). Z. Naturforsch. 13a, 609-20(1958) Aug. (In German)

The state of a rarefied gas, whose particles have a characteristic angular momentum (spin) of constant value (quantum number J), however variably oriented (quantum number M), was described by a distribution matrix $f_{MN}(t, \vec{r}, \vec{c})$ with 2J + 1 states. The scattering amplitude matrix $a_{M'M|,MM_1}(\vec{e}',\vec{e},k)$ for the collision of two bodies in the center of mass system, that is, for the scattering of a even wave with the wave number k and the direction $\vec{e}$ to the new direction $\vec{e}'$ with corresponding spin arrangement, was assumed known. Then one can give a general expression for the change of the expected value of a chosen operator $O_{MN}(\vec{c})$ in the two-body collision. This expression was applied to the gas and leads to the Maxwell transport equation for the average value $\bar{0}$. Equations are given for the Lorentz gas and for the pure gas. From the transport equation, the Boltzmann collision equation for particle spin is obtained. It is a matrix equation. The contribution of the collision to the change of f consists of two terms. One term is bilinear in the scattering amplitude $a,a^+$; it was integrated over all collision directions. This term indicates how many particles of a given velocity and spin orientation "originate." The other term is linear in the scattering amplitude a or $a^+$; they are taken as the forward direction $\vec{e}' = \vec{e}$. This term indicates how many particles of the given kind "vanish." In the approximation of the isotropic spin orientation, the distribution matrix is proportional to the unit matrix. By use of the shadow theory (optical theory) for the scattering amplitude one comes, in this formal approximation, back to the familiar Boltzmann equation for single atomic gases (from spinless particles) with an effective cross section which arose by approximation to the mean over-all spin positions and for which the "detailed balance" relation is valid. For the single spin state there is no such direct relation. It is therefore satisfactory that the rigorous Boltzmann equation for spin particles is distinctly different formally from that for spinless particles. (tr-auth)

# Instruments

*Refer also to abstracts 16982 and 17946.*

**17554** CWR-468

Curtiss-Wright Corp. Research Div., Quehanna, Penna. A RADIOISOTOPE TACHOMETER. J. K. Kelly, N. E. Figurel, A. E. Heiges, and J. A. Curll. Apr. 30, 1957. 43p.

The results tabulated demonstrate the soundness of radioisotope tachometry as a method of measuring speed and direction of rotation. The tachometer was designed, built, and given thorough laboratory tests. These tests indicate that an accuracy of about 1% can be expected up to the maximum speed tested (17,600 rpm). It is further indicated that this system is accurate to much higher speeds. By simulating the scintillator signal with a sine wave, accurate counting was obtained beyond 50,000 counts per minute. However, since the limit of the mechanical test equipment prevented testing above 17,600 rpm with the radioisotope, experimental proof of the above statement was not possible. If an application for this tachometer is found for speeds in excess of 20,000 rpm, it may become necessary to increase the source strength to maintain the desired statistical accuracy. (auth)

**17555** SCTM-221-58(14)

Sandia Corp., Albuquerque, N. Mex. DC POWER CONVERSION—TRANSVERTERS. A. B. Church, June 20, 1958. 26p. Contract AT(29-1)-789. $4.80(ph OTS); $2.70(mf OTS).

The mechanism by which transistor drive-limiting causes switching in transformer coupled transverters is described for the non-saturating transformer case and is then extended to the saturating transformer case. The design equations for transverters are derived, and some of the design considerations are discussed. A discussion of the four transistor bridge circuit in comparison with the usual push-pull circuit is included. The advantages of a separate saturating transformer for both circuits are presented and a new method of using capacitor coupling to the saturating transformer primary for increasing switching speed is described. (auth)

**17556** SCTM-279-58(51)

Sandia Corp., Albuquerque, N. Mex. INSTRUMENTATION AT EET FIRING SITE. C. W. Huddle. July 14, 1958. 15p. Contract AT(29-1)-789. $3.30(ph OTS); $2.40(mf OTS).

The instrumentation used at the firing site for explosive-electric transducer units is described. The firing circuit, recording equipment, calibrating equipment, and pretest measurement equipment are discussed. (W.D.M.)

**17557** SCTM-291-58(14)

Sandia Corp., Albuquerque, N. Mex. HYBRID MAGNETIC PULSER. C. R. Blaine. July 29, 1958. 14p. Contract AT(29-1)-789. $3.30(ph OTS); $2.40(mf OTS).

The wide gap between the 1258 and 3C45 hydrogen thyratrons can partially be filled by using magnetic pulse shaping in conjunction with the 1258 thyratron. A circuit has been developed using one stage of magnetic pulse shaping with a 1258 thyratron. A saturable-core pulse transformer is used to shape the trailing edge of the output pulse. The circuit was designed to operate over a temperature range from −65°C to +75°C and a ±10% change in input voltage. By correctly designing the saturable core used for pulse shaping a certain amount of voltage regulation can be obtained. (auth)

**17558**

A METHOD FOR SHORT TIME MEASUREMENT WITH ANY ADJUSTABLE TIME SPAN AND HIGH MEASURING ACCURACY. Werner Kroebel (Univ. of Kiel, Germany). Atomkern-Energie 3, 289-94(1958) Aug.-Sept. (In German)

A method of short time measurements is described. It has a wide field of application, but for the present it is restricted to periodic events which can be triggered. An extension to non-periodic events seems to be possible. From a main-frequency source pulses are derived as standard time marks; there are two or more channels for dividing this frequency, delivering trains of low-frequency pulses, whose space from the standard pulses can be varied by means of goniometers. These pulses can be distinguished as far as the interval is smaller than the period of the low-frequency pulses. This method allows time measurements — especially in oscillographic devices — in the range from nanoseconds to seconds with an accuracy depending only on the period of the main-frequency. The accuracy is independent of the absolute space and can be made smaller than $10^{-10}$ seconds by suitable choice of the main-frequency. (auth)

**17559**

DIRECT-COUPLED AMPLIFIER FOR THE MEASUREMENT OF SMALL CURRENTS. B. R. F. Kendall (Univ. of Western Australia, Nedlands). Nuclear Instr. 3, 73-9 (1958) Aug.

Methods for the reduction of grid current noise and leakage currents in direct-coupled preamplifier circuits are discussed. It is shown that, by combining a cathode follower preamplifier with a negative feedback output circuit, input grid resistors of very high value can be used. The construction and performance of an amplifier using these principles is described. Features of this circuit are a high zero stability and an adjustable time constant. (auth)

**17560**

RELATIVISTIC THEORY OF THE SPHERICAL ELECTROSTATIC ANALYZER. Neil Ashby (Harvard Univ., Cambridge, Mass.). Nuclear Instr. 3, 90-6(1958) Aug.

A general relativistic analysis of the properties of spherical electrostatic analyzers is presented, and applied to some special cases of interest. An important limitation on the allowable kinetic energies is shown to exist: for energies greater than a certain kinetic energy $T_{max}$, the spherical analyzer is not an effective focusing instrument. Expressions for the velocity and energy dispersions, and for the resolving power, are derived. A special case, in which the central angle of the analyzer is greater than $3\pi/2$, and which has desirable focusing properties, is briefly discussed. (auth)

**17561**

20 Mc/s SCALING CIRCUIT. B. Collinge and G. B. Huxtable (Nuclear Physics Research Lab., Liverpool). Nuclear Instr. 3, 116-18(1958) Aug.

A scaling circuit is described which will operate at frequencies greater than 20 Mc/s. Particular attention is paid to reliable triggering. (auth)

**17562**

NOTES ON A FAST TIME-TO-AMPLITUDE CONVERTER. R. E. Green and R. E. Bell (McGill Univ., Montreal). Nuclear Instr. 3, 127-32(1958) Sept.

A time-to-amplitude converter with a full resolution width of $8.5 \times 10^{-10}$ sec is described. The circuit is based on the 6BN6 gated beam tube operated at unusually low electrode voltages. An additional supervisory fast coincidence circuit ensures that output pulses are produced only when the pulse delay lies within the desired time interval, thus avoiding the double-valued time-to-amplitude conversion inherent in such systems. Examples of the performance of the apparatus are shown for prompt coincidences and for the delayed coincidence distribution observed when positrons annihilate in fused quartz. The time-to-amplitude converter is easily added to an existing fast-slow coincidence assembly. (auth)

**17563**

ELECTRONIC EQUIPMENT FOR MEASURING IONIZATION IN NUCLEAR PLATES. A. De Marco, R. Sanna, and G. Tomasini (Univ. of Genoa and Istituto Nazionale di Fisica Nucleare, Genoa). Nuovo cimento (10) 9, 524-32(1958) Aug. 1.

The drum revolution of a motor-driven microscope micrometric eyepiece is read by means of a phototube arrangement originating calibrated electric pulses. The pulses are counted and compared by an equipment incorporating one decade counter tube channel and several condenser storage counters. Final information including track length, mean gap length, and gap distribution is directly displayed by electromechanical counters. An analysis of condenser storage counters is given. (auth)

**17564**

A CODED PULSE GENERATOR IN THE NANOSECOND RANGE. U. Pellegrini (Comitato Nazionale Ricerche Nucleari, Rome). Nuovo cimento (10) 9, 533-7(1958) Aug. 1. (In Italian).

A regenerative pulse generator is described which can be used for generating a group of coded pulses. The operation of the circuit is discussed and the characteristics of the output pulses are given: minimum pulse width and spacing are 15-and $25 \times 10^{-9}$ sec respectively; the amplitude and the number of coded pulses are controllable. (auth)

**17565**

LINEAR AMPLIFIER FOR NEGATIVE PULSES. A. S. Penfold (Univ. of Chicago). Rev. Sci. Instr. 29, 765-6 (1958) Sept.

A two-tube, noninverting, linear amplifier is described. It has a gain of 100 and an inherent rise time of 50 mμsec for outputs up to 125 v. The amplifier recovers promptly from pulses which overload it a factor of 100. (auth)

**17566**

SENSITIVE SINGLE CHANNEL PULSE-HEIGHT ANALYZER. M. Simhi and M. Birk (Weizmann Inst. of Science, Rehovoth, Israel). Rev. Sci. Instr. 29, 766-8 (1958) Sept.

A stable sensitive single channel pulse-height analyzer is described, in which 6BE6 pentagrid tubes paralleled by vacuum diodes are used as linear discriminators. The analyzer works with input pulses of 4- to 40-mv amplitude, and it can be operated directly by a scintillation detector. The dead time is approximately 6 μsec, and the stability of the instrument over a period of several days is better than 1%. (auth)

**17567**

ELECTRON-PERMEABLE WINDOW FOR CATHODE-RAY TUBES. Jerrold Seehof, Stuart Smithberg, and Melvin Armstrong (National Cash Register Co., Hawthorne, Calif.). Rev. Sci. Instr. 29, 776-8(1958) Sept.

An ultrathin window, permeable to low-energy electrons, was developed for use with cathode-ray tubes and associated devices. This window, some 70 μin. thick, has the ability to withstand greater than 1-atmos pres-

sure differential and, at the same time, allow a 15-kv electron beam to penetrate it. Window structures are composed of a ¼-in. square matrix (80-mesh nickel screen) supported bentonite clay film. It is expected that larger area configurations can be developed. The films are relatively gas-tight and are insensitive to temperatures of at least 400°C. (auth)

**17568**

CERAMIC CUTTING TOOLS. A. U. Margules. Stanki i Instr. No. 4, 39-40(1958).

The geometry of ceramic tool tips, fixing them to the tool-holder by bonding or clamping, cutting speeds, and feeds as practiced at the Voroshilovgrad Diesel Locomotive Plant are illustrated and described. The cutting of components with a Rockwell C hardness of 46 is carried out with a 0.5 mm depth of cut. A built-up milling cutter for cast iron is shown. Tool bits cast-in into an aluminum tool-holder achieve cutting speeds of 1,000 m/min. (TCO)

## Isotopes

**17569** ISC-1006

Ames Lab., Ames, Iowa.

SHAPE OF THE PHOSPHORUS 32 BETA ENERGY SPECTRUM. George B. Henton and B. C. Carlson. Dec. 1957. 66p. Contract W-7405-eng-82.

The shape of the beta energy spectrum of $P^{32}$ was determined by making a least squares fit of the experimental data. This was compared with the shape expected when interference between matrix elements of different orders of forbiddenness is assumed. The experimental shape factor was found to fit a straight line decreasing by two percent over the energy range measured. However, a satisfactory fit was also made to a Fierz interference shape factor which is approximately of the form $1 + r/W$, where r is a small parameter and W is the energy of the beta particle. Shape factors calculated assuming interference between matrix elements of different orders of forbiddenness were nearly linear, decreasing by eight to twelve percent with increasing energy. If shell model wave functions are assumed, the transition is from a $(\pi s\ 1/2, \gamma\ d\ 3/2)\ J = 1$ configuration to a $(\pi s\ 1/2)^2\ J = 0$ configuration. The interaction was assumed to be purely tensor (no Fierz interference). The second-forbidden matrix elements were evaluated for the nuclear configuration mentioned above. Since the allowed matrix element $S\beta\vec{\sigma}$ is zero for this configuration, its small but nonzero value was estimated from the experimental ft value. The slope of the calculated shape factor depends to some extent on the choice of radial wave functions: it decreases by 12% if an isotropic harmonic oscillator is used, and by 8% in the case of a square well of infinite depth. (auth)

**17570**

THE MASSES OF $^{13}C$, $^{14}N$ AND $^{15}N$. R. A. Demirkhanov, T. N. Gutkin, and V. V. Dorokhov. J. Nuclear Energy 7, 255-63(1958) Sept.

New measurements of the $C^{13}$, $N^{14}$, and $N^{15}$ isotope masses are reported. Internal consistency is shown by the mass values derived from different doublet systems. The measurements were carried out under conditions which excluded systematic error. A precise method to adjust the ion-focusing system is described. The values are found to be $13.007491 \pm (3 \times 10^{-6})$, $14.007527 \pm (4 \times 10^{-6})$, and $15.004890 \pm (5 \times 10^{-6})$ mass units for $O^{13}$, $N^{14}$, and $N^{15}$ respectively, and these are in good agreement with those published previously by Nier et al. These results are higher than the average values obtained from nuclear reactions and statistical analysis. The discrepancy is explained by inaccuracies in the Q values used in the calculation of the masses of the original isotopes $n_0$, H, D, $He^4$, and $C^{12}$ and the isotopes $C^{13}$, $N^{14}$, and $N^{15}$. (auth)

**17571**

ISOTOPE ABUNDANCY DETERMINATIONS OF TITANIUM AND ZIRCONIUM. Hans-Werner Drawin (Atlas-Werke AG., Bremen). Nukleonik 1, 109-12(1958) Aug. (In German)

The isotopic abundancies of titanium and zirconium were measured with a single-focusing mass spectrometer at 60°. The ions were produced in a thermal ion source. Because of the oscillating thermal ion emission only the double collector ratio measurement was suitable for accurate isotopic abundance determinations. The frequencies obtained from these measurements show deviations from earlier measurements made by A. O. Nier, but agree within the limits of error with later measurements by J. E. Hoog. (tr-auth)

**17572**

DISCOVERY OF A NEW MENDELEVIUM ISOTOPE. L. Phillips, R. Gatti, A. Chesne, L. Muga, and S. Thompson (Univ. of California, Berkeley). Phys. Rev. Letters 1, 215-17(1958) Sept. 15.

Helium ion bombardments of $Es^{253}$ resulted in the identification of a new isotope of mendelevium with mass number 255. The isotope decays by orbital electron capture to $Fm^{255}$, with a half life of $\sim$½ hr. The daughter isotope was identified by its alpha energy and half life. $Md^{255}$ may also decay by alpha branching with an energy of 7.34 Mev, but the evidence for this is not conclusive. The observations of spontaneous fission events from $Fm^{254}$ in the mendelevium and fermium fractions confirmed the decay of $Md^{256}$ by electron capture. (W.D.M.)

**17573**

GAMMA RADIATION FROM THE DECAY OF $^{113}Sn$. R. K. Girgis and R. Van Lieshout (Instituut voor kernphysisch Onderzoek, Amsterdam). Physica 24, 672-82 (1958) Aug.

The gamma radiation accompanying the decay of 118 day $Sn^{113}$ was studied with scintillation detectors, using kicksorters. The relative intensities of the 393 kev and the 257 kev gamma ray were found to be 100 : (3.0 ± 0.3). Chemical separations show that the 257 kev radiation belongs to $Sn^{113}$ and not to its 1.75 hour $In^{113}$ daughter. There is some evidence for a weak transition of 605 ± 10 kev. Remarks about the decay scheme are added. (auth)

## Isotope Separation

**17574** K-1247

Oak Ridge Gaseous Diffusion Plant, Tenn.

SEPARATION OF URANIUM ISOTOPES BY ELECTROMIGRATION IN FUSED URANIUM TETRACHLORIDE. J. W. Grisard and S. S. Kirslis. Aug. 28, 1958. Decl. Sept. 18, 1958. 13p. Contract W-7405-eng-26. $3.30 (ph OTS); $2.40(mf OTS).

Separation of uranium isotopes by countercurrent electromigration in fused uranium tetrachloride has been demonstrated on a laboratory scale. A separation factor of 1.005 ± 0.001 was obtained between cathode and anode samples with an average current of 0.13 amperes for 116 hours; this value corresponds to an electromigration separation coefficient of 1.00036 ± 0.00007. (auth)

**17575**

ON DISTILLATION COLUMNS FOR ISOTOPE SEPARATION. F. I. Havliček (J. Stefan Institut, Ljubljana, Yugoslavia). Energia nucleare (Milan) 5, 527-30(1958) Aug.

Equations were derived for steady and transient operation of distillation columns for isotope separation. Some diagrams were also plotted in order to determine the optimal height of the columns in a cascade with respect to the output. The influence of the single-process separation factor on these results was also investigated. (auth)

**17576**

LARGE SCALE SEPARATION OF BORON ISOTOPES. A. L. Conn and J. E. Wolf (Standard Oil Co., Whiting, Ind.). Ind. Eng. Chem. 50, 1231-4(1958) Sept.

The design, construction, and operation of the first large-scale plant for separating boron isotopes are presented. The dimethyl ether complex was fractionated to obtain a liquid product in which 95% of the boron present was $B^{10}$. Boron metal was produced from this enriched material. (J.R.D.)

**17577**

ION SOURCE FOR RADIOISOTOPE SEPARATION. J. O. Burgman and G. Andersson (Univ. of Uppsala). Nuclear Instr. 3, 33-42(1958) July.

An ion source of the oscillating electron type with axial magnetic field and end extraction has been constructed for electromagnetic separation of synchrocyclotron-produced radioactive isotopes. A description of the ion source and the results of some systematic investigations of its properties are given. The performance of the ion source is illustrated by some recent applications to prepare sources for spallation studies and nuclear spectroscopy. (auth)

**17578**

CONTRIBUTION TO THE THEORY OF SEPARATION OF STABLE ISOTOPES. V. K. Turkin. Trudy Mosh. Chim. Tekhnol. Univ. vyp. 22, 247-51(1956). (Translated from Referat. Zhur. Fiz. No. 5, 1957, Abstract No. 11065.)

Formulas are derived for the calculation of the separation of isotopes in an arbitrary number of stages. Expressions are also derived for the concentration of the isotope in the stream entering the stage and for the concentration in the enriched and impoverished streams leaving the stage. (J.S.R.)

## Mass Spectrography

**17579**

MASS SPECTROGRAPH WITH CORRECTED IMAGE ERRORS. L. A. König and H. Hintenberger (Max-Planck-Institut für Chemie, Mainz). Nuclear Instr. 3, 133-48(1958) Sept. (In German)

The general expressions for second-order angle aberration, angle-velocity aberration, and velocity aberration of mass spectrometers consisting of a radial electric field and a homogeneous magnetic sector field in series, are developed for the special case of mass spectrographs with double focusing of the first order for all masses along a straight image curve. The possibilities for correcting these image defects are investigated. Tables are presented of solutions for apparatus types in which at one point of the image curve all three or two of the image defects simultaneously vanish. Almost each apparatus with simultaneous correction of the three image defects possesses a large radial field. On the other hand there are useful solutions according to which either the two image defects depending on aperture or the two depending on velocity vanish. The numerical calculations were carried out by means of an IBM-magnetic-drum-computer, type 650. The computation procedure is outlined briefly. (auth)

## Mathematics

*Refer also to abstracts 17352, 17353, 17376, and 17392.*

**17580** AECU-3839

Illinois. Univ., Urbana. Digital Computer Lab.
TECHNICAL PROGRESS REPORT. PART I. HIGH-SPEED COMPUTER PROGRAM. PART II. MATHEMATICAL METHODS. PART III. ILLIAC USE AND OPERATION—GENERAL LABORATORY INFORMATION. July 1958. 18p. Contracts AT(11-1)-415; N6ori-07130; and Nonr-1834(15). $3.30(ph OTS); $2.40 (mf OTS).

(For preceding period see AECU-3805.) (D.E.B.)

**17581** NARF-58-34T

Convair, Fort Worth, Tex.
APPLICATION OF WIENER-HOPF METHOD TO TRANSPORT THEORY. N. Edmonson. Sept. 8, 1958. 60p. Project 6(1-9964). Contract AF33(600)-32054. (MR-N-202).

Milne's equation is derived as an example of an equation of the Wiener-Hopf type. The basic mathematical theory of the Wiener-Hopf method is developed, and a number of physical problems solvable by the Wiener-Hopf method are presented. A discussion of the application of the Wiener-Hopf method to the non-homogeneous integral equation is included. (auth)

**17582** NYO-7979

New York Univ., New York. Atomic Energy Commission Computing and Applied Mathematics Center.
A NUMERICAL SCHEME FOR SOLVING A BOUNDARY VALUE PROBLEM FOR THE TRICOMI EQUATION. Dorothy Levy. Mar. 19, 1958. 45p. Contract AT(30-1)-1480. $7.80(ph OTS); $3.30(mf OTS).

The Tricomi equation $y\,u_{xx} + u_{yy} = 0$ is a 2nd order partial differential equation of mixed type. It is elliptic in the upper half plane, hyperbolic in the lower half plane, and degenerate parabolic on the x-axis. A scheme for solving this equation numerically is given and proved convergent. (auth)

**17583** SCTM-230-58(15)

Sandia Corp., Albuquerque, N. Mex.
CHAIN SAMPLING PLANS. C. R. Clark. May 26, 1958. 13p. Contract AT(29-1)-789. $3.30(ph OTS); $2.40 (mf OTS).

The chain sampling plan to reduce sample sizes is considered. These plans are useful where high reliability is required but testing is destructive, difficult, or expensive, and it is recommended that such plans be used if necessary conditions are satisfied. (auth)

**17584** UCRL-5240-T

California. Univ., Livermore. Radiation Lab.
UCRL CODES FOR MOTION OF ASTRONOMICAL OBJECTS IN THE SOLAR SYSTEM. Progress Report No. 1: January 1956 to June 1, 1958. Richard Levee and Joseph L. Brady, Jr. June 2, 1958. 6p. Contract W-7405-eng-48. $1.80(ph OTS); $1.80(mf OTS).

This progress report describes four IBM 704 codes developed and used by UCRL, Livermore, to investigate the motion of any object in the force fields of the sun and

any or all of the planets and their satellites. These four codes are classified as follows: The THEMIS CODE—a double precision integration all purpose code; The SATELLITE CODE—a single precision integration code developed mainly for earth satellites and other objects requiring a small number of integration steps; The DIFFERENTIAL CORRECTION and REPRESENTATION CODE—corrects a set of starting values and represents observations of an earth satellite; The LIFETIME CODE—predicts lifetimes by energy loss and angular momentum gain considerations. Lifetime predictions for several satellites are given. (auth)

**17585** UCRL-5243

California. Univ., Livermore. Radiation Lab.

ON THE PRAGER-SYNGE "HYPERCIRCLE METHOD IN MATHEMATICAL PHYSICS." Arnold N. Lowan. July 1958. 44p. Contract W-7405-eng-48. $1.25(OTS).

If L′ denotes the function space spanned by the vectors which "correspond" to the gradients of functions which are twice differentiable with respect to x and y for points P(x,y) in a plane region R and assume prescribed values on the boundary C of R, and if L″ denotes the function space spanned by the vectors which correspond to vectors in R whose divergence vanishes, then the gradient of the Dirichlet problem for the given region is the intersection S of L′ and L″. The search for S leads to the search for the "shortest distance" between two suitably chosen subspaces $L'_t$ and $L''_t$ of L′ and L″, respectively, the subspaces being orthogonal in an appropriately defined sense. When the points V′ (in $L'_t$) and V″ (in $L''_t$) for which $(V'-V'')^2$ is minimum are determined, it is shown that S lies on the "hypercircle" with center C and radius R where C and R depend on V′ and V″ and the parameters which characterize $L'_t$ and $L''_t$. When R is small the functions which correspond to the components of the position vector C may be considered as approximations to the functions which correspond to the components of the gradient of the desired solution. The accuracy of the approximation may be gauged from the magnitude of $R^2$ which is equal to the integral of the square of the difference between the gradient of the desired solution and the approximate gradient, over the given region R. (auth)

**17586** WAPD-CPM-M-109

Westinghouse Electric Corp. Bettis Plant, Pittsburgh.

F0031 [IBM-704 CODE]. Paul A. Gillis. May 5, 1958. 3p. $1.80(ph OTS); $1.80(mf OTS).

An IBM-704 code, F0031, fits a set of up to 500 points to the curve $y = Ae^{xp}(Bx) + C$ by the least squares technique. The input for a problem consists of a title card, instruction card, and data cards. The title card contains any 72 characters punched in columns 2 to 72 for identification purposes. The instruction card format is given. (auth)

**17587** WAPD-T-788

Westinghouse Electric Corp. Bettis Plant, Pittsburgh.

ORDERINGS OF THE SUCCESSIVE OVERRELAXATION SCHEME. Richard S. Varga. July 1958. 24p. Contract AT-11-1-Gen-14. $4.80(ph OTS); $2.70(mf OTS).

This paper was presented at the Chicago meeting of the American Mathematical Society, April 18, 1958.

One of the more frequently used iterative methods in numerically solving partial difference equations of elliptic type is the Young—Frankel successive overrelaxation scheme. The effect of different orderings of the equations of this scheme on the rate of convergence is discussed. Special attention is given to orderings based on the Perron—Frobenius theory of non-negative matrices. (D.E.B.)

**17588**

ON THE RELATION BETWEEN S-MATRIX AND POTENTIAL FOR THE ONE-DIMENSIONAL SCHROEDINGER OPERATOR. L. D. Faddeev (Zdanov Lenigrad State Univ.). Doklady Akad. Nauk S.S.S.R. 121, 63-6 (1958) July 1. (In Russian)

A one-dimensional Schroedinger equation was developed along the complete axis $-\infty < x < \infty$ with the condition $\int^{\infty} [1 + (x)]\, q(x)\, dx < \infty$. The functions obtained are used in determining the potential in relation to the S matrix. Results are formulated in a theorem. (R.V.J.)

**17589**

FIRST COLLISION PROBABILITY, $P_c$, IN REGIONS WITH CIRCULAR SYMMETRY. P. A. Jewitt and S. E. Barden (AEI-John Thompson Nuclear Energy Co., Ltd., Knutsford, Cheshire, Eng.). J. Nuclear Energy 7, 222-5(1958) Sept.

The method developed by Gerggenheim and Pryce (1945) for the rigorous calculation of first collision probabilities in hollow tubes has been extended to a geometry in which a solid cylindrical rod is surrounded by a concentric tube of the same material. This particular geometry is only a special case of the general problem associated with multi-annular tubes, and is investigated in order to determine the effectiveness of smearing-out the solid material in such concentric regions uniformly within the outer perimeter of the tube. The results of the investigation are presented graphically. (A.C.)

**17590**

GENERAL FORMULAS FOR GAP-EXCITED LINEAR DUCTS. J. Van Bladel (Midwestern Universities Research Association and Univ. of Wisconsin, Madison). Nuclear Instr. 3, 52-6(1958) July.

Equations allowing determination of the electric and magnetic fields at each point within a gap-excited metallic duct are derived. With the application to accelerators in mind, formulas are established for the energy and lateral momentum kicks to which a particle is subjected upon crossing the gap region. The configuration where the gap is in a plane perpendicular to the duct's axis is given some special attention. (auth)

**17591**

FOLDY-DOUTHUYSEN TRANSFORMATION. EXACT SOLUTION WITH GENERALIZATION TO THE TWO-PARTICLE PROBLEM. Erik Eriksen (Univ. of Oslo). Phys. Rev. 111, 1011-16(1958) Aug. 1.

The Dirac Hamiltonian for a particle in a nonexplicitly time-dependent field is converted to an even Dirac matrix by means of a single canonical transformation. When the interaction term is an odd Dirac matrix, the transformed Hamiltonian is expressed in a very simple form. An exact transformation is also found for two-particle wave equations of Breit's type. The transformed Hamiltonian is then a uU-separating matrix, in Chraplyvy's sense. In the nonrelativistic limit expansions in powers of 1/m or 1/c are made. The approximate wave equations are in agreement with previous transformation results. (auth)

## Measuring Instruments and Techniques

*Refer also to abstract 17374.*

**17592** CR-Tec-282

Atomic Energy of Canada Ltd. Chalk River Project, Chalk River, Ont.

APPARATUS AND METHODS USED FOR THE CALI-

BRATION OF CHALK RIVER ION-CHAMBERS, TYPES TPA TPJ AND TPD. C. O. Peabody. Aug. 5, 1946. Reprinted Sept. 1958. 18p. (AECL-294). $0.50 (AECL).

The methods used to test and calibrate ion chambers types TPA, TPJ, and TPD are described. Details are given of the measurement of ion-current by means of a d-c amplifier, Lindemann electrometer, and sensitive galvanometer. Estimates are made of the experimental errors involved in calibration measurements. (auth)

**17593** MTec-245

Atomic Energy of Canada Ltd. Chalk River Project, Chalk River, Ont.

CHARACTERISTICS OF CHALK RIVER ION-CHAMBERS TYPES TPA, TPD AND TPJ. B. S. Smith, C. O. Peabody, and D. S. Craig. Apr. 12, 1946. Decl. Nov. 29, 1955. Reprinted March 1958. 33p. (AECL-291). $1.00(AECL).

Data, supplementing those found in Report AECL-290 are given on the saturation characteristics and current sensitivities of the TPA, TPD, and TPJ type ion-chambers. (auth)

**17594** ORNL-2583

Oak Ridge National Lab., Tenn.

BIBLIOGRAPHY ON SEMICONDUCTOR NUCLEAR RADIATION DETECTORS. James L. Blankenship. Oct. 3, 1958. 12p. Contract W-7405-eng-26. $0.50 (OTS).

This bibliography consists of 72 references from the published literature on the potential uses of semiconductors as nuclear radiation detectors. Most references on the uses of cadmium sulfide have been omitted, except for recent articles, because excellent bibliographies have already been prepared. (auth)

**17595** UCRL-8333

California. Univ., Berkeley. Radiation Lab.

TRANSIENT BEHAVIOR OF THE BERKELEY BUBBLE CHAMBER MOTOR GENERATOR MAGNET SYSTEM DURING EMERGENCY PROCEDURE. Alper Garren and Warren Heckrotte. June 19, 1958. 23p. Contract W-7405-eng-48. $0.75(OTS).

The transient behavior of the electrical system for the Berkeley bubble-chamber magnets under certain emergency procedures is examined theoretically. Conditions for nonoscillating behavior of the magnet current are derived. (auth)

**17596** USNRDL-TR-248

Naval Radiological Defense Lab., San Francisco.

CHARACTERISTIC CURVES FROM DIFFERENT IONIZING RADIATIONS AND THEIR SIGNIFICANCE IN PHOTOGRAPHIC DOSIMETRY. R. Golden and E. Tochilin. June 23, 1958. 25p.

Characteristic curves for six different emulsions have been obtained with nuclear radiations of a wide range of specific ionization. Sources included alpha particles, protons, neutrons, and beta, gamma, and x rays. The two most sensitive films (Eastman Type K and Dupont Type 555) exhibited identical characteristic curves for all exposures. Curves for the remaining films were found to be dependent on the type of radiation. When log density was plotted against log exposure, the curves fell into two groups. For particles with specific ionization equal to or greater than that produced by 30 kev x rays, the slope in the linear region approached 1.0. For high-energy beta rays, gamma rays, and electrons, slopes greater than one were obtained. In most cases identical saturation densities were observed. Data are presented which show that gamma-ray characteristic curves can be simulated with beta rays. This technique can considerably simplify exposure procedures, particularly where high-level exposures are involved. (auth)

**17597** NP-tr-134

USE OF A PHOTOGRAPHIC FILM AND SCINTILLATING CRYSTAL SYSTEM TO RECORD GAMMA RADIATION. R. M. Kogan and N. K. Pereyaslova. Translated by P. Collins (U.K.A.E.A. Atomic Energy Research Establishment) from Pribory i Tekh. Eksptl'. No. 4, 25-7 (1957). 6p.

Data concerning the use of a scintillating crystal, NaI(Tl), and photographic film for gamma radiation dosimetry were produced. The sensitivity of such a system is $10^4$ times higher than that obtained by the direct use of photographic film, and further improvements are indicated. (J.R.D.)

**17598**

CORRECTIONS IN ABSOLUTE $\beta$ -DOSIMETRY WITH THE AID OF GEIGER-MULLER COUNTERS. Jiri Stary. Askosl. Casop. Fys. 7, No. 1, 90-8(1957). (Translated from Referat. Zhur. Fiz. No. 1, 1958, Abstract No. 309)

An investigation was made of all types of corrections, with the exception of self-absorption. Particular attention was paid to the dependence of the backward scattering factor $f_b$ on $E_{max}$ and on the geometry. It is found that $f_b$ increases with increasing $E_{max}$ in the region from 0.17 to 1.7 Mev, but for backings with low Z, the value of $f_b$ remains practically constant. If the geometric factor is less than 30%, then $f_b$ is independent of the energy. For the radiation itself, $f_b$ increases noticeably together with the geometric factor.

**17599**

NEW TYPE OF GAMMA INDICATOR. A. V. Bibergal' and M. M. Korotkov (Inst. of Biological Physics, Academy of Sciences, USSR, Moscow). Biofizika 1, No. 6, 564-7(1956). (Translated from Referat. Zhur. Fiz. No. 5, 1957, Abstract No. 11053)

A description in given of two laboratory models of a simple, compact, and sensitive dosimeter, suitable for the measurement of the intensity of gamma or beta radiation. The dosimeter comprises a combination of Geiger-Mueller counters with a string electrometer, and does not contain vacuum tubes. Since the electrometer operates in the static mode, and the counter requires not more than 1 to 2 $\mu$a at full load, the instrument is practically currentless, which insures reliable and stable operation under the field conditions. The dosimeter is fed from two wafer batteries. One of these batteries feeds the halogen counter, while the other is connected to the electrometer plates. The counter current passes through an integrating network of a resistor and capacitor in parallel, which are simultaneously connected between the filament of the electrometer and the center point of the second battery. The voltage drop across the resistor as a result of the average counter current causes a displacement of the filament of the electrometer. The limits of the measured intensity of radiation can be varied by changing the RC network. The first model of the instrument has ranges 0.05 to 5 and 3 to 250 microroentgen per second, weighs 1.4 kg, and is formed in the shape of a "pistol" measuring 200 × 100 × 80 mm. The length of the moving scale, on which the filament is projected is 50 mm. In the second model the Lauritsen electrometer is used, which makes it possible to reduce the dimensions of the instrument and to reduce the weight to 0.5 kg.

**17600**

THE THEORY OF LATENT IMAGES PRODUCED BY CHARGED PARTICLES AND THE INFLUENCE OF

SPECIFIC ENERGY LOSS AND GRANULATION IN THE REGION NEAR MINIMUM IONIZATION. Marie-Cécile Le Gentil and Max Morand. Compt. rend. 247, 741-4 (1958) Sept. 1. (In French)

The application of the Mitchell theory relative to the formation of the latent image beginning with positive holes and the quantum calculation relative to atomic collisions leads to values very favorable for fluctuations of granulation. (tr-auth)

**17601**

CONVERTING A GAS FLOW ALPHA PROPORTIONAL COUNTER TO THE SCINTILLATION TYPE. J. R. Mann (Dow Chemical Co., Denver.). Health Phys. 1, 192-4 (1958) Sept.

A schematic sketch is presented of a photomultiplier and amplifier circuit which may be used for the conversion of a gas flow alpha proportional counter to a scintillation type counter. (C.H.)

**17602**

IMPROVEMENTS IN THE THRESHOLD DETECTOR METHOD OF FAST NEUTRON DOSIMETRY. P. W. Reinhardt and F. J. Davis (Oak Ridge National Lab., Tenn.). Health Phys. 1, 169-75(1958) Sept.

Improvements have been made in the threshold detector method for measuring fast neutron spectra and tissue dose. The sensitivity of the counters used to measure the induced activity of the detecting elements has been increased by a factor of 12 to 16 times by improving counting geometry. Holding the gain of the scintillation counting system constant by an automatic monitoring arrangement reduces the time required for standardization. The method of $P^{32}$ recovery from $S^{32}$ by burning out the sulfur has been shown to be reproducible and to have a recovery efficiency of 93.5 per cent. The neutron cross-sections for various detection elements used in the threshold detection system are reviewed. (auth)

**17603**

LARGE-AREA DISTILLED WATER CHERENKOV COUNTER. B. N. Srivastava (D.S.B. Government Coll., Naini Tal, India). J. Sci. Ind. Research (India) 17B, 281-2(1958) July.

A distilled water Cherenkov counter was designed and constructed. The design and performance characteristics of this instrument are described. (J.R.D.)

**17604**

ATOMIC BEAM RESONANCE APPARATUS WITH SIX-POLE MAGNETS FOR RADIOACTIVE ISOTOPES. Ingvar Lindgren (Univ. of Uppsala). Nuclear Instr. 3, 1-16(1958) July.

The construction of an atomic beam resonance apparatus with focusing six-pole magnets for measurements of spins and magnetic moments of radioactive nuclei is reported. The principles of the design and of maximizing the intensity are discussed. The effective solid angle, averaged over the velocity distribution of the beam, has been calculated to be about $3 \times 10^{-4}$ steradians in a typical case, which is one order of magnitude larger than can be obtained by the conventional method. (auth)

**17605**

STATISTICAL SPREAD IN PULSE SIZE OF THE SCINTILLATION SPECTROMETER. A. Bisi and L. Zappa (Instituto de Fisica Sperimentale del Politecnico, Milan). Nuclear Instr. 3, 17-24(1958) July.

The results of an experimental investigation concerning the statistical spread of the pulse sizes of the scintillation spectrometer are reported. It was found that for $\gamma$-ray energies lower than 800 kev the measured half-width $\eta$ of the lines fit strictly the relation $\eta^2 = \alpha + \beta/E$ where the two constants $\alpha$ and $\beta$ vary slightly from one spectrometer to another. At higher energies the half-widths appear to be considerably smaller than predicted from the previous relation. All the experimental results are compared with statistical predictions. (auth)

**17606**

IMPROVED NaI SCINTILLATION SPECTROMETER FOR THE STUDY OF CONTINUOUS X-RAY SPECTRA. G. Hettinger and N. Starfelt (Univ. of Lund). Nuclear Instr. 3, 25-6(1958) July.

The K x ray escape fraction of a NaI scintillation spectrometer is essentially reduced by letting the collimated x rays to be studied enter through a narrow well in the crystal. (auth)

**17607**

PHOTOGRAPHIC BENT CRYSTAL GAMMA SPECTROMETER. Olof Beckman (Inst. of Physics, Uppsala). Nuclear Instr. 3, 27-32(1958) July.

A 1-meter bent crystal gamma-ray spectrometer is described. The gamma lines are registered on Ilford G5 nuclear emulsions. By counting with a microscope the electron tracks forming a line, it is possible to determine gamma intensities. Corrections have to be made for emulsion efficiency, crystal reflectivity, and the geometry of the spectrometer. The accuracy of this method is controlled by the measurements of some known lines in $Ta^{182}$. In addition the energies and intensities of two lines in $Sm^{153}$ are given: 69.66 ± 0.02 kev and 103.18 ± 0.04 kev; intensity ratio 9 to 100. (auth)

**17608**

PROPOSITION FOR A NEW METHOD FOR MEASURING SHORT HALF-LIVES. B. Johansson and T. Alväger (Nobel Inst. of Physics, Stockholm). Nuclear Instr. 3, 49-51(1958) July.

A method of measuring half lives is proposed to determine isomeric states decaying slower than $10^{-14}$ seconds. The principle is explained by a hypothetical case in which two K-conversion electrons are emitted in cascade. The time between these two events can be determined by fixing the start time of the first electron from its phase position in a high-frequency voltage supplied between two condenser plates. The second electron emitted in coincidence with the first one obtains a deflection which is a function of the phase difference with respect to the first one. Test arrangements and variations of the method are discussed. (J.R.D.)

**17609**

A NEW METHOD IN GAMMA-RAY SPECTROSCOPY: A TWO CRYSTAL SCINTILLATION SPECTROMETER WITH IMPROVED RESOLUTION. A. M. Hoogenboom. Nuclear Instr. 3, 57-68(1958) Aug.

A new method has been developed to measure the spectra of gamma radiation emitted in cascade disintegrations. Use is made of a two-crystal scintillation spectrometer and a gated multi-channel analyzing device. The pulses produced by summing the outputs of the two crystal-photomultiplier combinations are selected by a single-channel differential discriminator. The output of this differential discriminator gates the multi-channel analyzer whenever the sum pulse corresponds to the release in the crystals of the full energy available in the cascade. The spectrum displayed is that of either of the two detectors. The most important features of the technique are as follows: (a) only "full-energy" peaks are detected; (b) improved resolution is obtained especially at higher gamma-ray energies; (c) one $\gamma-\gamma$ or $p-\gamma-\gamma$ angular correlation experiment determines the angular correlation of the gamma rays of all double cascades

deexciting a given level. Details of operation and typical spectra are presented. It is suggested that the technique be called the "sumcoincidence" method. (auth)

**17610**

DISTINGUISHING BETWEEN $He^3$ AND $He^4$ PARTICLES BY 'dE/dx' AND "E" MEASUREMENTS. R. W. P. McWhirter, P. Palit and E. H. Bellamy (Univ. of Glasgow). Nuclear Instr. 3, 80-4(1958) Aug.

A new type of detector has been built to distinguish between $He^3$ and $He^4$ particles of a continuous energy spectrum ranging from about 10 to 30 Mev. It consists of two gridded ionization chambers which measure the total energy of the particle in two fragments "$E_1$" and "$E_2$," in general $E_1$ being < $E_2$. The information is displayed in a cathode ray oscilloscope by a series of spots whose co-ordinates are proportional to the values of $E_1$ and $E_2$ for each particle. The positions of the spots are compared to calculated positions to determine the total energy and mass of the particle concerned. The apparatus has been used to study the reaction $\gamma + He^4 \rightarrow \pi^0 + He^4$ by picking up the recoil $\alpha$ particle amidst a large background of $He^3$ and singly charged particles. It is currently being used to investigate the photodisintegration of oxygen, argon, and krypton at high energies. (auth)

**17611**

ON THE THEORY OF THE DIFFUSION CLOUD CHAMBER. Igor Saavedra (Univ. of Chile, Santiago). Nuclear Instr. 3, 85-9(1958) Aug.

A revision is made of Shutt's theory by using more accurate expressions describing the transport phenomena in the chamber. This leads to a new expression for the temperature gradient. The importance of the correction thus introduced depends upon the particular components of the binary mixture considered. (auth)

**17612**

INVESTIGATION OF A BETA-RAY SPECTROMETER WITH A TRIANGULAR FIELD. Ingvar Lindgren (Univ. of Uppsala). Nuclear Instr. 3, 104-8(1958) Aug.

A long lens beta-ray spectrometer with a pure "triangular" field is investigated theoretically. A point source as well as a disk source is considered. It is shown that the effect of the source width on the resolution is much smaller with this field than with a uniform field. The spherical aberration is rather large, but the maximum luminosity at a given resolution is larger than with a uniform field. The results are in agreement with experiments. (auth)

**17613**

TRANSFORMATION OF A PULSE SPECTRUM RECORDED IN THE BINARY NUMBER SYSTEM TO A RECORDED CURVE. S. Wagner (Physikalisch-Technische Bundesanstalt, Brunswick). Nuclear Instr. 3, 119-20(1958) Aug. (In German)

A simple method is described allowing the transformation of a pulse spectrum pattern displayed as binary numbers on a cathode ray screen of a multichannel analyzer into a recorded curve. (auth)

**17614**

EFFECTS CAUSED BY ELECTRON COLLECTION IN A CYLINDRICAL IONIZATION CHAMBER. Georges Hall (Université Laval, Quebec). Nuclear Instr. 3, 121-6 (1958) Sept. (In French)

The effect of using electron collection in a cylindrical, pulse ionization chamber is analyzed. Ionizing trajectories crossing the chamber from end to end and ideal conditions are assumed. The probability of observing pulses of a given amplitude is shown to depend on this amplitude. The resulting statistical distribution of pulse amplitudes to be expected under typical conditions of operation is calculated as an example, from Landau's theoretical distribution of energy losses. (auth)

**17615**

MEASUREMENT OF CIRCULAR POLARIZATION OF $\gamma$-RAYS. Herwig Schopper (Inst. of Nuclear Physics, Mainz). Nuclear Instr. 3, 158-76(1958) Sept.

The various methods for the detection of circularly polarized $\gamma$-rays are surveyed, and detailed calculations of effects limiting the obtainable accuracy are communicated. (auth)

**17616**

INSTRUMENTATION. Nucleonics 16, No. 9, 83-5(1958) Sept.

A survey is presented of the papers given at Geneva on low-level beta counting, gamma measurement, and scintillation counting. (J.S.R.)

**17617**

A NEW LARGE-SURFACE FLOW-THROUGH COUNTER FOR THE IMPROVED DETERMINATION OF THE OVER-ALL RADIOACTIVITY IN WATER BY AN EVAPORATION METHOD. Hans Kiefer and Rupprecht Maushart (Strahlenmessgruppe der Kernreactor-Bau- und Betriebs-Gesellschaft m.b.H., Karlsruhe, Germany). Nukleonik 1, 103-6(1958) Aug. (In German)

A windowless flow-through counter with 7 counter wire loops and a usable counter surface of 300 $cm^2$ is described. In large aluminum pans which are inserted in the base of the counter housing, water can be evaporated with a surface evaporator. The improvement obtained in contrast with earlier sorts of evaporators is described by comparative measurements. (tr-auth)

**17618**

EXPERIMENTS WITH SELF-QUENCHING COUNTERS IN TEMPERATURES UP TO 350°C. Gerd Hagemann and Erich Huster (Univ. of Marburg, Germany). Nukleonik 1, 106-8(1958) Aug. (In German)

The behavior of a self-quenching counter was investigated at temperatures up to 400°C. At 350°C good plateaus could still be obtained. The quality of the plateaus depends on the condition of the cathode surface and the pressure of the gas. The best results were obtained with a heavily oxidized copper cathode and a gas filling of argon–hexane (4:1). The optimum gas density for the best plateau increases, at least with this mixture, with increasing temperature. (tr-auth)

**17619**

A COINCIDENCE CIRCUIT WITH RESOLVING TIME OF 2.2 NANOSEC AND DEAD TIME OF 5 NANOSEC OF POSSIBLE USE IN NUCLEAR PHYSICS. U. Pellegrini, B. Rispoli, and A. Serra (Centro Coordinamento Elettronica, Rome and Univ. of Rome). Nuovo cimento (10) 9, 171-83(1958) July 1. (In Italian)

A new high resolution coincidence circuit has been studied for scintillation or Cherenkov counter experiments. The resolving time has been found to be 2.2 nanosecond and the circuit is suitable for 5-fold or 6-fold coincidence arrangement. The circuit is given, and the coincidence curve is shown. The circuit has a sensitivity of about 3 v and dead time of about 5 nanosecond. The characteristics of the circuit as well as the characteristics of the conventional coincidence circuits have been measured. (auth)

**17620**

DETERMINATION OF THE CIRCULAR POLARIZATION OF THE $\beta$-RAY BREMSSTRAHLUNG WITH A NEW $\gamma$-POLARIMETER. E. G. Beltrametti and S. Vitale (Univ. of Genoa and Istituto Nazionale di Fisica Nu-

cleare, Genoa). Nuovo cimento (10) 9, 289-94(1958) July 16.

The circular polarization of the bremsstrahlung produced by the $P^{32}$ $\beta$ rays has been measured with an analyzer recently proposed by Beard and Rose. The degree of polarization is found to be consistent with the theoretical previsions. The polarimeter is found to work quite satisfactorily. (auth)

**17621**

EXPERIMENTAL STUDY OF THE METHOD OF BUBBLE FORMATION IN BUBBLE CHAMBERS. Walter I. Goldburg (Carnegie Inst. of Tech., Pittsburgh). Phys. Fluids 1, 353-4(1958) July-Aug.

To help put a lower limit on the sensitive time of organic liquids commonly used in bubble chambers a static electric field of 15 kv/cm was applied across a small propane bubble chamber which was then expanded in the conventional manner when a beam of 450 Mev protons was passed through it. The bubble density along the tracks was measured with both field on and field off. Within statistics (±4%) no difference in bubble density was observed for the two cases. To interpret this result it is assumed that δ rays produce bubbles if they deposit a certain minimum amount of energy within a critical volume of the liquid. It is then concluded from this experiment that either recombination effects are not important in bubble formation or that the recombination time of ions in a critical volume of propane is $\lesssim 10^{-11}$ sec. This figure appears to represent a reasonable theoretical estimate of the sensitive time of propane, liquid hydrogen, and liquid helium. (auth)

**17622**

AN ANALYSIS OF THE FREE-AIR IONIZATION CHAMBER FOR EXTENDED SOURCES OF RADIATION. J. H. Aitken (National Research Council, Ottawa). Phys. in Med. and Biol. 3, 27-36(1958) July.

Some of the factors affecting the accuracy of absolute measurements of x-ray exposure dose using a free-air ionization chamber are discussed. Analytical criteria have been derived which may assist in the design of primary standardizing facilities. In particular, the influence of the dimensions of the x-ray source and the entrant diaphragm of the chamber on the accuracy of the measurements is clarified. (auth)

**17623**

AN IONIZATION CHAMBER FOR DIAGNOSTIC X-RADIATION. S. B. Osborn and R. G. Burrows (University Coll. Hospital, London). Phys. in Med. and Biol. 3, 37-43(1958) July.

An ionization chamber is described of about 40 $cm^3$ volume suitable for measurement of x radiation between 45 kv and 120 kv up to dose-rates in excess of 1000 r/min. (auth)

**17624**

FAST SODIUM IODIDE SPECTROMETER AND ITS APPLICATION TO MILLIMICROSECOND TIME MEASUREMENT. L. E. Beghian, G. H. R. Kegel, and R. P. Scharenberg (Massachusetts Inst. of Tech., Cambridge). Rev. Sci. Instr. 29, 753-7(1958) Sept.

A scintillation counter using pure NaI cooled to liquid nitrogen temperature has been developed. The photopeaks of $Co^{57}$ $\gamma$ rays (122 kev) and $Cs^{137}$ $\gamma$rays (662 kev) were found to have a full width a half-height of 33 and 14%, respectively. A 7-inch quartz light pipe was used between scintillator and photomultiplier. The decay time of the fluorescent light was found to be 27 mμsec. For fast time measurements a time-to-pulse-height converter was constructed, which operates in the range from 0 to 100 mμsec. The converter was used in conjunction with two scintillation counters using plastic (Pilot B) scintillators. The time resolution for the detection of annihilation $\gamma$ rays was found to be $2\tau_0$ = 2.3 mμsec. With one plastic and the cooled NaI scintillator the time resolution was found to be $2\tau_0$ = 2.7 mμsec. The possible factors contributing to the time resolution are discussed. (auth)

**17625**

IMPROVED METHOD OF GAMMA-RAY CALORIMETRY. I. T. Myers (General Electric Co., Richland, Wash.). Rev. Sci. Instr. 29, 758-61(1958) Sept.

A method of using an isothermal calorimeter is described in which experimental errors are minimized by the proper selection of the time of measurement. The method was applied to the calorimetric measurement of the activity of a 2-curie cobalt-60 source. (auth)

**17626**

GAP LENGTH ANALYZER FOR NUCLEAR EMULSION TRACKS. S. C. Bloch (Univ. of Miami, Coral Gables). Rev. Sci. Instr. 29, 789-90(1958) Sept.

A gap length analyzer for nuclear emulsion tracks is described which provides simultaneously the number of gaps greater than any eight predetermined minimum gap lengths. (A.C.)

**17627**

CsI CRYSTAL MOUNTING FOR HIGH-RESOLUTION PARTICLE DETECTION. A. E. Souch and D. R. Sweetman (A.W.R.E., Aldermaston, Berks, Eng.). Rev. Sci. Instr. 29, 794-5(1958) Sept.

A mounting is described for attaching a thallium-activated cesium iodide crystal directly on the face of a Dumont 6292 photomultiplier tube for high-resolution particle detection. (A.C.)

**17628**

EFFECT OF WALLS IN A SPHERICAL IONIZATION CHAMBER. O. F. Hemets. Ukrain. Fiz. Zhur. 2, No. 2, 101-5(1957). (Translated from Referat. Zhur. Fiz. No. 1, 1958, Abstract No. 295)

Formulas are derived that take into account the effect of the walls in a spherical ionization chamber, intended for the investigation of spectra of fast neutrons. An example of the use of the formulas is given.

**17629**

DOSIMETRY OF IONIZING RADIATIONS. 2nd Edition, Revised. Konstantin Konstantinovich Aglintsev. Moscow, Gostekhizdat, 1957. 503p.

This revised and enlarged edition was brought up to date by the inclusion of chapters on scintillation, chemical, and calorimetric methods of dosimetry. The electronic recording of radiation is also discussed. 279 references. (J.S.R.)

## Mesons

**17630** AFOSR-TN-58-819
Stanford Univ., Calif.
NUCLEON FORM FACTORS FROM ELECTROPRODUCTION OF PIONS. Technical Report No. 37. S. Gartenhaus and C. N. Lindner. Sept. 1958. 19p. Project No. 9750-37500. Contract AF49(638)-388. (AD-202351).

The dispersion relation analysis of Fubini, Nambu, and Wataghin for electro-pion production was applied to the experiments of Panofsky and Allton as an independent means for studying nucleon structure. The results are in qualitative agreement with those from elastic scatter-

ing experiments. Some of the limitations inherent in the form factor measurements by this process are also discussed. (auth)

**17631** NP-6960

Joint Inst. for Nuclear Research, Moscow. Lab. of Nuclear Problems.

POLARIZATION EFFECTS IN THE REACTION $p + p \rightarrow d + \pi^+$ WITH A CONSIDERATION OF THE s-, p-, AND d- STATES OF THE $\pi$-MESON. L. M. Soroko. 1958. 20p.

Explicit expressions for all the observed effects in the reaction $p + p \rightarrow d + \pi^+$ with a consideration of the s-, p-, and d- states of the $\pi$-meson are given. (auth)

**17632** NP-6963

Joint Inst. for Nuclear Research, Moscow. Lab. of Theoretical Physics.

A POSSIBLE METHOD FOR THE DETERMINATION OF THE PARITY OF STRANGE PARTICLES. S. M. Bilenky. 1958. 7p.

A method is proposed for determining the intrinsic parity of K mesons and hyperons, based on a study of the reactions $\pi + p \rightarrow \Lambda\ (\Sigma) + K$ and $K + p \rightarrow \Lambda\ (\Sigma) + \pi$ on a polarized proton target. (D.E.B.)

**17633**

A POSSIBLE EXPERIMENT FOR DETERMINATION OF SPIRALITY OF $\mu$-MESONS. A. Z. Dolginov (Physico-Technical Inst., USSR Academy of Sciences, Leningrad). Nuclear Phys. 7, 569-72(1958) Aug.

For the determination of the direction of the $\mu$-meson spin with respect to its momentum it is suggested that circular polarization of x-ray quanta emitted by a mesic atom be investigated. This should simultaneously yield information on the degree of depolarization of $\mu$-mesons after a certain level is reached in the mesic atom. (auth)

**17634**

DIFFRACTION SCATTERING AND INTERACTIONS OF 0.57 Bev $\pi^-$ IN EMULSIONS. A. Barbaro, G. Baroni, and C. Castagnoli (Univ. of Rome and Istituto Nazionale di Fisica Nucleare, Rome). Nuovo cimento (10) 9, 154-61(1958) July 1.

A study of 570-Mev negative pion interactions with nuclei (and nucleons) is carried out with nuclear emulsion techniques. Particular attention is given to diffraction scattering. The results on 152.2 m track agree, as far as absorption is concerned, with the predictions of an optical model using dispersion rules and a Fermi-type nuclear density distribution. The diffraction cross section, instead, comes out larger than that predicted by the model, and this seems to confirm the results obtained with other techniques. (auth)

**17635**

ENERGY DEPENDENCE OF POSITRON ASYMMETRY FROM POLARIZED MUON DECAY IN EMULSION. C. Castagnoli, A. Manfredini (Univ. of Rome and Istituto Nazionale di Fisica Nucleare, Rome), and A. W. Merrison (Univ. of Liverpool). Nuovo cimento (10) 9, 186-7(1958) July 1.

To verify theoretical predictions of energy dependence, the energy dependence of the angular asymmetry of 1,001 positrons from the decay of mesons coming to rest in nuclear emulsions was studied. Within statistical limits the agreement between experimental results and the predictions of a simple nonderivative coupling theory is considered satisfactory. (L.T.W.)

**17636**

ASSOCIATED PRODUCTION OF A $K^+$ MESON AND A HYPERFRAGMENT. Tsai-Chü, B. Chemel, and S. Desprez- Rebaud (Faculte des Sciences, Sorbonne, Paris). Nuovo cimento (10) 9, 192-4(1958) July 1.

Associated production of a $K^+$ meson and a hyperfragment was observed in nuclear emulsions exposed to cosmic radiation. The two strange particles were emitted from a small star of type 7 + 1n. Each prong of the star, except one at minimum ionization, comes to rest in the emulsion. The minimum ionizing prong is identified as a K meson. One slow prong is a hyperfragment showing neutral mesic decay. It is probable that the interaction takes place between a photon of energy (1.37 ± 0.10) Bev and a proton of a heavy emulsion nucleus resulting in the production of a $K^+$ meson and a $\Delta^0$ hyperon. The hyperon interacts with the nucleus and causes the hyperfragment. (L.T.W.)

**17637**

CORRELATED POLARIZATION OF MUONS IN $K_{\mu 3}$-DECAY. S. W. MacDowell (Univ. of Birmingham, Eng.). Nuovo cimento (10) 9, 258-62(1958) July 16.

The relativistic density matrix formalism developed by Stapp is used to calculate the polarization vector of muons from $K_{\mu 3}$ decay and the depolarizing effects due to high-energy atomic collisions. (auth)

**17638**

HYPERON POLARIZATION IN ASSOCIATED PRODUCTION AND HEAVY MESON PARITY. D. Amati (Univ. of Rome and Istituto Nazionale di Fisica Nucleare, Rome) and B. Vitale (Univ. of Naples and Scuola di Perfezionamento in Fisica Teorica e Nucleare del C. N. R. N., Naples). Nuovo cimento (10) 9, 340-2(1958) July 16.

Accurate measurements of the angular dependence of the polarization of the hyperons produced in the associated production by pions are suggested as a rather sensitive test of the hypotheses concerning H-K parity, where H is a $\Lambda$ or a $\Sigma$ hyperon. It is shown that quantitative estimates of the polarization intensity can be obtained from the differential cross sections, once the K-H-N interaction is treated as weaker than the $\pi$-N interaction. (L.T.W.)

**17639**

PION PRODUCTION IN THE $K^+$-NUCLEON INTERACTION. C. Ceolin, N. Dallaporta, and L. Taffara (Univ. of Padua and Istituto Nazionale di Fisica Nucleare, Padua). Nuovo cimento (10) 9, 353-7(1958) July 16.

The value and the behavior of the cross section for secondary pion production from $K^+$-nucleon scattering are calculated. (L.T.W.)

**17640**

PRELIMINARY RESULTS OF $K^+$ INTERACTION AT HIGH ENERGY (200 TO 350 Mev). M. Grilli, L. Guerriero, M. Merlin, Z. O'Friel, and G. A. Salandin (Univ. of Padua and Istituto Nazionale di Fisica Nucleare, Padua). Nuovo cimento (10) 9, 358-61(1958) July 16.

A stack of 240 Ilford G-5 pellicles was exposed to a doubly focussed $K^+$ beam (p = 625 Mev/c). All K tracks were followed for ~9 cm, and the interactions were recorded in the range 200 to 350 Mev. The nature and energy of the interacting particles were determined. (L.T.W.)

**17641**

THE SCATTERING OF $\mu$-MESONS IN LEAD AND COPPER. W. F. Nash and A. J. Pointon (Univ. of Nottingham, Eng.). Nuovo cimento (10) 9. 412-21(1958) Aug. 1.

The scattering distributions of $\mu$-mesons in lead and copper were investigated using a cloud chamber operated underground at a depth of 40 m of water. At high momenta

the observed scattering distributions are similar to those given by Molière for a "point" nucleus at large angles. It is shown that the results are consistent with a cross-section that varies as $A^2$ or $Z^2$ but not as Z or A. (auth)

**17642**

ON THE ABUNDANCES OF THE $K_3$ AND $K_{e3}$ DECAY MODES OF POSITIVE K MESONS. M. Bruin, D. J. Holthuizen, and B. Jongejans (Univ. of Amsterdam). Nuovo cimento (10) 9, 422-32(1958) Aug. 1.

The abundances of the $K_{\mu 3}$ and $K_{e3}$ decay modes were checked in a large emulsion stack using the criteria of Alexander et al. The results agree completely with those of Birge et al. The weighted average of these and comparable corrected results of others yields a relative abundance of (3.9 ± 0.5) % for $K_{\mu 3}$ and of (5.1 ± 0.8) % for $K_{e3}$ decay. Available experimental data on the electron spectrum of the $K_{e3}$ decay mode are compiled and compared to theoretical calculations by Furuichi et al. No evidence is found for an abnormally short mean free path of the positive secondary pions from $K_{\pi 2}$ decay as previously reported by Alexander et al. (auth)

**17643**

NEUTRAL PION DECAY. M. L. Goldberger and S. B. Treiman (Princeton Univ., N. J.). Nuovo cimento (10) 9, 451-60(1958) Aug. 1

Neutral pion decay is studied quantitatively with dispersion relation techniques. The process is pictured as proceeding mainly through pion disintegration into baryon pairs, the latter annihilating to produce the photons. In detail only the nucleon pair is taken into account, as representative of baryon pair contributions generally. The final expression for the decay rate has a structure very different from what one obtains in perturbation theory. It turns out, however, that the numerical results are not appreciably different. (auth)

**17644**

A NOTE ON AN ACAUSALITY TEST (II). D. Ito (Univ. of Education, Tokyo), S. Minami (Osaka City Univ.) and H. Tanaka (Univ. of Bologna and Istituto Nazionale di Fisica Nucleare, Bologna). Nuovo cimento (10) 9, 461-9(1958) Aug. 1.

The forward scattering amplitude $M(\omega)$ (real part $D(\omega)$, imaginary part $A(\omega)$ in pion nucleon scattering is discussed when the acausal spread of the current commutator over the space-like interval is very small. If the acausal smearing is so small as to justify the treating of its effect as a perturbation, the errors of the dispersion relations are proved to be energy independent in the first order approximation. Hence, there would be no guarantee of affecting micro-causality even if the dispersion relations written, as they are, in a form of subtraction $D(\omega) - D(\mu)$ could be in agreement with the experiment. (auth)

**17645**

QUESTION OF A SECOND NEUTRAL PION. A. M. Baldin and P. K. Kabir (Univ. of Birmingham, Eng.). Nuovo cimento (10) 9, 547-50(1958) Aug. 1.

To remove the discrepancy between calculated and experimental values of the Panofsky ratio, it was suggested that the neutral pions emitted when $\pi^-$ mesons are absorbed in hydrogen may not be the usual $\pi^0$ meson occurring in symmetric meson theory, but may have isotopic spin T=O. This proposal is discussed. (W.D.M.)

**17646**

TEST ON THE GLOBAL SYMMETRY. D. Ito (Univ. of Education, Tokyo), S. Minami (Osaka City Univ.), and H. Tanaka (Univ. of Bologna and Istituto Nazionale di Fisica Nucleare, Bologna). Nuovo cimento (10) 9, 554-5 (1958) Aug. 1.

A possible test of the global symmetry proposed independently by Gell-Mann, Schwinger, and Tiomno is discussed. The discussion is confined to the case of final three-body reactions where the conservation of energy and angular momentum appear less restrictive for a pair among the final three particles. (W.D.M.)

**17647**

ON ELECTROMAGNETIC CORRECTIONS FROM HIGH ENERGY VIRTUAL PHOTONS. R. Gatto and M. Ruderman (Univ. of Rome, and Istituto Nazionale di Fisica Nucleare, Rome). Nuovo cimento (10) 9, 556-9 (1958) Aug. 1.

The relevance of a recent suggestion on the theory of pion decay of the form $\pi \rightarrow e + \nu$ is discussed and expanded. (W. D. M.)

**17648**

ALTERNATIVE METHOD FOR DETERMINING THE PION-NUCLEON FORWARD SCATTERING AMPLITUDE. H. P. Noyes (Univ. of Liverpool, and Univ. of California, Livermore). Phys. Rev. 111, 944-7(1958) Aug. 1.

Since existing experiments fail to confirm the Goldberger form of the pion-nucleon dispersion relations, and no satisfactory theoretical or experimental explanation has been found, it is clearly desirable to increase the precision of this conclusion. It is shown that by extending the measurements of the $\pi^+ + p$ differential elastic cross sections down to about 15° c.m., the real parts of the forward scattering amplitudes can be measured directly with precision comparable to that obtained for the cross sections. This method depends on the assumption of charge independence only through explicitly given $e^2/\hbar v$ corrections, and above 100 Mev is less sensitive to these corrections than the method of Puppi and Stanghellini. Comparison between the results obtained by the two methods would give a useful test for the presence of systematic error. (auth)

**17649**

SEARCH FOR MASS-550 PARTICLES. J. W. Keuffel, R. L. Call, W. H. Sandmann, and M. O. Larson (Univ. of Utah, Salt Lake City). Phys. Rev. Letters 1, 203-5 (1958) Sept. 15.

The apparatus used in the search for cosmic-ray particles of mass ~550$m_e$ is described. It is concluded that the abundance of mass-550$m_e$ particles which decay into a light meson is less than about 0.05% relative to $\mu$ mesons. (W.D.M.)

**17650**

SEARCH FOR PARITY NONCONSERVATION IN THE ASSOCIATED PRODUCTION PROCESS. Frank S. Crawford, Jr., Marcello Cresti, Myron L. Good, Frank T. Solmitz, and M. Lynn Stevenson (Univ. of California, Berkeley). Phys. Rev. Letters 1, 209-12 (1958) Sept. 15.

An analysis of 236 events of the type $(\pi^- + p \rightarrow \Lambda + k^0) + (\Lambda \rightarrow p + \pi^-)$ produced by 1.12 Bev/c pions incident upon a liquid hydrogen bubble chamber is presented. The results are consistent with zero decay asymmetry in the production plane. The data are thus a good fit to the hypothesis that parity is conserved in associated production. (W.D.M.)

**17651**

$K^+$ MESON-NUCLEON SCATTERING PHASE SHIFT ANALYSIS. O. R. Price, D. H. Stork, and H. K. Ticho (Univ. of California, Los Angeles). Phys. Rev. Letters 1, 212-14(1958) Sept. 15.

A detailed phase-shift analysis of 125-Mev $K^+$ meson interaction data that makes full use of the diffuse-

surface optical-model approach and takes into account the effect of double scattering is presented. (W.D.M.)

**17652**

DECAY OF A NEGATIVE $\tau'$ MESON. S. C. Freden, F. C. Gilbert, and R. S. White (Univ. of California, Livermore). Phys. Rev. Letters 1, 217-18(1958) Sept. 15.

In a systematic study of negative K-meson decays and interactions in flight, an example of the $\tau'$ mode of decay was observed. A photomicrograph of the decay is shown. From the known momenta of the incident particles and the position of the decay point in the stack the energy of the $K^-$ meson at decay was determined to be 105 ± 10 Mev. (W.D.M.)

**17653**

STRONG INTERACTIONS AND ASSOCIATED PRODUCTION. Charles Warner, III (Harvard Univ., Cambridge, Mass.). Phys. Rev. Letters 1, 246-7(1958) Oct. 1.

The concept of a hierarchy of strong interactions allows a number of possibilities for the particular interaction Lagrangian. The production processes for $\Lambda K^\circ$, $\Sigma^\circ K^\circ$, $\Sigma^- K^+$, and $\Sigma^+ K^+$ from $\pi + N$ collisions were investigated in an attempt to reduce the possible choices. (W.D.M.)

**17654**

ELECTRON DECAY OF THE PION. T. Fazzini, G. Fidecaro, A. W. Merrison, H. Paul, and A. V. Tollestrup (CERN, Geneva). Phys. Rev. Letters 1, 247-9(1958) Oct. 1.

The apparatus used in the search for the high-energy electron from pion decay is described. Pions from the 600 Mev CERN synchrocyclotron were used in the experiment. A value of $4 \times 10^{-5}$ was found for the electron decay branching ratio. (W.D.M.)

**17655**

$\beta$ DECAY OF THE PION. G. Impeduglia, R. Plano, et al. (Columbia Univ., New York). Phys. Rev. Letters 1, 249-51(1958) Oct. 1.

A liquid $H_2$ bubble chamber, 12 in. diameter, 6 in. deep, 8800 gauss field, was exposed to a beam of slow $\pi^+$ mesons. The $\pi$-e events are distinguished from the $\mu$-e events by momentum measurements. Of 65,000 meson decays examined, six $\pi$-e events were found, which is close to the rate predicted theoretically. (W.D.M.)

**17656**

HELICITY OF THE PROTON FROM $\Lambda^0$ DECAY. Elihu Boldt, Herbert S. Bridge, David O. Caldwell, and Yash Pal (Massachusetts Inst. of Tech., Cambridge and Brookhaven National Lab., Upton, N. Y.). Phys. Rev. Letters 1, 256-8(1958) Oct. 1.

The magnitude of the longitudinal polarization and its sign as determined from the nuclear scattering of decay protons in iron is reported. The $\Lambda^0$ hyperons used in the measurement were produced in a multiplate cloud chamber exposed to 1.2 to 1.9 Bev negative pions from the Brookhaven Cosmotron. (W.D.M.)

**17657**

WILSON-PEIERLS AMBIGUITY IN HIGH-ENERGY PHOTOPRODUCTION. J. J. Sakurai (Univ. of California, Berkeley). Phys. Rev. Letters 1, 258-60(1958) Oct. 1.

It is pointed out that there exists a very definite possibility of resolving the $p_{3/2}$ vs $d_{3/2}$ ambiguity by measuring the polarization of the recoil proton in the reaction $\gamma + p \rightarrow + \pi^\circ + p$, and that such an experiment is indeed feasible. (W.D.M.)

**17658**

PHOTOPRODUCTION OF NEGATIVE $\pi$-MESONS ON DEUTERIUM NEAR THE THRESHOLD. M. I. Adamovich, G. V. Kuzmicheva, V. G. Larivnova, and S. P. Kharlamov (Lebedev Inst. of Physics, Academy of Sciences, USSR). Zhur. Eksptl'. i Teoret. Fiz. 35, 27-38(1958) July. (In Russian)

The investigation was performed on the 265 Mev synchrotron with photographic emulsions containing $D_2O$. Detailed information on the reaction $\gamma + d \rightarrow p + p + \pi^-$ was obtained for photon energies up to 200 Mev. Various experimental characteristics of the reaction are compared with the predictions of the impulse approximation. The experimental results are consistent with the theory which takes into account interaction between nucleons in the final state. It is shown that the square of the matrix element for photoproduction of $\pi$-mesons on neutrons near the meson threshold is a constant and equals $(0.785 \pm 0.072) \cdot 10^{-27}$ cm$^2$. This quantity corresponds to the ratio $\sigma^-/\sigma^+ = 1.34$. (tr-auth)

**17659**

INVESTIGATION OF THE FINAL STATES INVOLVED IN THE PHOTOPRODUCTION OF NEGATIVE $\pi$-MESONS ON DEUTERIUM. M. I. Adamovich (Lebedev Inst. of Physics, Academy of Sciences, USSR). Zhur. Eksptl'. i Teoret. Fiz. 35, 39-44(1958) July. (In Russian)

The $\gamma + d \rightarrow p + p + \pi^-$-reaction was studied with the aid of photographic emulsions. The angular distributions and energy spectra of mesons and of the relative motion of two protons were obtained near the threshold of photoproduction of mesons. The analysis indicates the existence of an electric dipole transition which leads to a change of the spin of the nucleon system and to production of mesons in the S-state. The shape of the spectra and the energy dependence of the cross section is explained with interaction between nucleons in the final state. (tr-auth)

**17660**

ENERGY SPECTRA AND ANGULAR DISTRIBUTION OF $\pi^+$-MESONS PRODUCED IN p-p-COLLISIONS AT 660-670 Mev. A. G. Meshkovskii, Ya. Ya. Shalamov, and V. A. Shebanov. Zhur. Eksptl'. i Teoret. Fiz. 35, 64-70 (1958) July. (In Russian)

The energy spectra of $\pi^+$-mesons produced in p–p-collisions at proton energies of 670 Mev were investigated for observation angles of 19°30', 38°, and 56°. It was found that in the cms the shape of the $\pi^+$-meson spectrum for the $pp \rightarrow pn\pi^+$-reaction depends on the emission angle. The angular distribution of $\pi^+$-mesons produced in 660 Mev p–p-collisions is given. The total cross section was found to equal $(14.4 \pm 1.2) \times 10^{-27}$ cm$^2$. (tr-auth)

**17661**

INVESTIGATION OF THE $p + p \rightarrow d + \pi^+$-REACTION ON A 536, 616 AND 654 Mev BEAM OF POLARIZED PROTONS. Yu. K. Akimov, O. V. Savchenko, and L. M. Soroko (Joint Inst. of Nuclear Research). Zhur. Eksptl'. i Teoret. Fiz. 35, 89-96(1958) July. (In Russian)

The angular dependence of the asymmetry of $\pi^+$-mesons emitted in the $p + p \rightarrow \pi^+ + d$-reaction was measured on a polarized beam of 536, 616, and 654 Mev protons. A direct proof of the existence of a d state of mesons in the $p + p \rightarrow \pi^+ + d$-reaction was obtained. Results of the experiment are consistent with the assumption that amplitudes of the s- and d-transitions are much smaller than that of the $^1D_2 \rightarrow {}^3S_1 p_2$ transition. Limiting estimates of the values of some of the partial cross sections are presented. (tr-auth)

**17662**
PHOTOPRODUCTION OF ELECTRONS AND $\mu$-MESON PAIRS ON NUCLEONS. I. T. Dyatlov. Zhur. Eksptl'. i Teoret. Fiz. 35, 154-8(1958) July. (In Russian)

Production of electron or $\mu$-meson pairs on nucleons by high energy $\gamma$ quanta is considered. It is shown under what conditions the cross sections for these processes can be expressed through the electromagnetic form factors of the free nucleon. (tr-auth)

**17663**
ON $\pi \rightarrow e + \nu + \gamma$-DECAY. V. G. Vaks and B. L. Ioffe. Zhur. Eksptl'. i Teoret. Fiz. 35, 221-7(1958) July. (In Russian)

$\pi \rightarrow e + \nu + \gamma$ decay is investigated for vector and axial-vector interactions. An exact relation between the probability of $\pi \rightarrow e + \nu + \gamma$-decay in vector theory and the probability of $\pi^0 \rightarrow 2\gamma$-decay can be established if one assumes that the direct interaction between $\pi$-mesons and the electron-neutrino field suggested by Gell-Mann and Feynman exists in the vector theory. It is ultimately found that in the total probability for $\pi \rightarrow e + \nu + \gamma$ decay the main role is played by decay due to axial interaction, the ratio of the total probability for $\pi \rightarrow e + \nu + \gamma$ decay to the probability for $\pi \rightarrow \mu + \nu$ decay being of the order of $5 \times 10^{-6}$. Expressions are obtained for the angular and energy distributions of the electrons and quanta. (tr-auth)

**17664**
$\pi$-MESIC ATOMS AND CORRECTIONS FOR DISPERSION RELATIONS. V. A. Meshcheryakov (Moscow State Univ.). Zhur. Eksptl'. i Teoret. Fiz. 35, 290(1958) July.

Calculations of $\pi$-mesic atom corrections for the reaction $\pi^- + p \rightarrow \pi^- + p$ indicate its small correction effects, explained by nearly 4% divergence of the $f^2$ bond constant in the vicinity of 120-Mev. (R.V.J.)

**17665**
STATISTICAL WEIGHT OF $K^+$ AND $K^-$ MESONS PRODUCED BY PION-NUCLEAR COLLISIONS. E. K. Mikhul (Joint Inst. of Nuclear Research). Zhur. Eksptl'. i Teoret. Fiz. 35, 298-9(1958) July. (In Russian)

Statistical weights are calculated in the Schwinger and Gell-Mann approximation of global interactions of pions with barions, and in the approximation when pion interactions with K, $\Lambda$, $\Sigma$, and $\Xi$ particles are much smaller than with nucleons. (R.V.J.)

**17666**
ANGULAR DISTRIBUTION OF CIRCULARLY POLARIZED $\gamma$ QUANTA ON $\mu$ MESIC ATOM. V. A. Dzhrbashyan (Inst. of Physics, Academy of Sciences, Armenian SSR). Zhur. Eksptl'. i Teoret. Fiz. 35, 307-8(1958) July. (In Russian)

The magnitude and direction of polarization of $\mu$ mesons produced by $\pi$-meson decays was studied in order to determine the angular correlation of polarized $\gamma$ quanta on $\mu$ mesons. (R.V.J.)

**17667**
DIFFRACTION SCATTERING OF FAST PARTICLES. D. I. Blokhintsev, V. S. Barashenkov, and V. G. Grishin (Joint Inst. of Nuclear Research). Zhur. Eksptl'. i Teoret. Fiz. 35, 311-12(1958) July. (In Russian)

An incident of elastic $\pi^-$ meson scattering at 1.3 Bev was analyzed in order to obtain data on the structure of elementary particles. (R.V.J.)

**17668**
ON THE POLARIZATION OF RECOIL NUCLEONS IN THE PHOTOPRODUCTION OF $\pi$-MESONS. N. F. Nelipa and V. A. Feoktistov (Lebedev Inst. of Physics, Academy of Sciences, USSR). Zhur. Eksptl'. i Teoret. Fiz. 35, 244-8(1958) July. (In Russian)

A general expression for the polarization of recoil nucleons appearing during the production of $\pi$ mesons by photons was obtained on the basis of the laws of conservation of momentum and parity. As an example an expression is given for polarization in a case of $\pi$-mesons production in s, p, and d states. (tr-auth)

## Microwaves

*Refer to abstract 17949.*

## Neutrons

*Refer also to abstracts 17342, 17352, 17353, 17376, and 17386.*

**17669** UCRL-4926-T(Rev.)
California. Univ., Livermore. Radiation Lab.
ELASTIC SCATTERING OF 14 MEV NEUTRONS (THEORETICAL CURVES). F. Bjorklund and S. Fernbach. July 1957. 36p. Contract W-7405-eng-48. $7.80(ph OTS); $3.30(mf OTS).

Theoretical differential cross sections computed from the optical model for 14-Mev neutrons are presented for a large number of nuclei. The parameters used for the calculations were selected on the basis of best fit to existing experimental data. (auth)

**17670**
INVESTIGATION OF THE ENERGY SPECTRUM OF NEUTRONS FROM A Po–Be SOURCE WITH THE PHOTOGRAPHIC EMULSION METHOD. L. Medveszky (Nuclear Research Inst., Hungarian Academy of Sciences, Dobrecsen, Hungary). Acta Phys. Acad. Sci. Hung. 6, No. 2, 261-72(1956). (Translated from Referat. Zhur. Fiz. No. 5, 1957, Abstract No. 11046)

A thick beryllium layer was bombarded with $\alpha$ particles from polonium coated on a platinum disk 3 mm in diameter. The neutron spectrum of the reaction $Be^9(\alpha,n)C^{12}$ was measured from the recoil protons in nuclear photoemulsions (100 microns). 12,000 tracks were processed. The neutron spectrum disclosed maxima at energies of 1.3, 4.4, and 6.9 Mev. The maximum energy of the neutrons was 10.7 Mev. The energy distribution of the neutrons obtained is in considerable disagreement with existing data. In the author's opinion, this may be explained both by the greater statistical error of his measurements compared with other works, as well as by the unique geometry he employs.

**17671**
INVESTIGATIONS ON THE POSSIBLE DEFLECTION OF THERMAL NEUTRON CURRENTS. Helmut Völcker (Univ. of Kiel, Germany). Atomkern-Energie 3, 295-8 (1958) Aug.–Sept. (In German)

In general thermal columns associated with research reactors produce a horizontal current of thermal neutrons whereas a vertical current offers some advantage. The possibility of changing the direction of the current from horizontal to vertical has been investigated by means of diffusion theory. At an optimal assembly it is shown that a turn-round in a solid corner of moderator is unreasonable. On the other hand a calculation based on the Albedo concept shows that a solution of the problem is given by a prismatic hollow corner consisting of one diffusion length thick walls of graphite, which connects two cubic columns situated perpendicular to each

other. The result as a function of geometry is discussed. (auth)

**17672**

DISCUSSION OF A NUMERICAL METHOD FOR THE IMPROVEMENT OF THE RESOLVING POWER IN THE NEUTRON CHOPPER. Gerhard Locke. Atomkern-Energie 3, 299-304(1958) Aug.-Sept. (In German)

An approximation method is described which permits the computation of a source neutron spectrum f(τ) from the time distribution of neutron intensity m(t) measured at the end of the flight path of a chopper. If the measured neutron intensity m(t) varies considerably in a time of flight interval, comparable with the length of the neutron pulses, m(t) will differ considerably from f(t) (resonance peaks). With a wellknown transport function of the chopper the approximation method applied to m(t) will permit a computation with good accuracy of f(t) if the time channels are small compared with the length of the neutron pulse. Resolution will be improved by a factor of 5 to 10. (auth)

**17673**

MEASUREMENT OF THE MEAN FREE PATH OF NEUTRON TRANSPORT IN GRAPHITE. Y. Droulers, J. Lacour, and V. Raievski (C. E. N., Saclay, France). J. Nuclear Energy 7, 210-14(1958) Sept. (In French)

The mean free path of neutrons in graphite was measured by the complex diffusion length method described at the Geneva Conference V report P/360 (1955). The anomalies were explained and eliminated and the precision of the measurements was increased. The new value obtained is 2.53 ± 0.03 cm for graphite of density 1.6 g/cm$^3$. (auth)

**17674**

ON THE SLOWING DOWN RELAXATION TIME FOR NEUTRONS IN MODERATORS. G. S. Mani (Atomic Energy Establishment, Trombay, India). J. Nuclear Energy 7, 220-2(1958) Sept.

In a previous investigation it was shown that the slowing down properties of a moderator could be determined from the rate of decay of thermal neutrons from an instantaneous source of fast neutrons. The assumption was made that the transport mean free path of neutron in the moderator is independent of neutron energy and that the rate of slowing down of neutrons is exponential in time. It is shown that the first assumption may lead to large errors and that the second assumption is not necessary. When a burst of fast neutrons is injected into a finite moderator, the neutrons rapidly slow down by elastic collision until they reach very nearly the binding energy of the atoms. This stage of slowing down can be treated classically except for complications arising from angular distribution of scattered neutrons and inelastic levels of moderator nuclei. For neutron energy less than the binding energy of the atoms, the classical treatment fails, since the neutrons no longer lose energy by elastic billiard-ball collisions. Equations are given for the decay rate of thermal neutrons and the diffusion coefficient for neutrons at equilibrium temperature. (A.C.)

**17675**

ON THE FERMI AGE OF NEUTRONS IN IRON AND STAINLESS STEEL. Matts Roos (A. B. Atomenergi, Stockholm). J. Nuclear Energy 7, 225-7(1958) Sept.

Under certain circumstances, the Fermi age of fast neutrons thermalized within a homogeneous medium can be calculated by the well known integral $\tau(E_2,E_1) = \int_{E_1}^{E_2} dE/3\xi\Sigma_s(E)\cdot\Sigma_{tr}(E)\cdot E$. For pure iron, this integral has been evaluated by Horton (1957) in the energy range 0.025 ev to 2 Mev, by using the values of the scattering cross section plotted in the compilation by Hughes and Harvey (1955), and performing the integration graphically. The total cross section curves of iron have suffered an appreciable change, as plotted in more recent supplementary compilation by Hughes and Schwartz, and it has proved necessary to repeat Horton's integration using these new cross sections. (A.C.)

**17676**

A NEW DEVELOPMENT IN THE AREA METHOD OF NEUTRON RESONANCE ANALYSIS. J. E. Lynn (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Nuclear Phys. 7, 599-612(1958) Aug.

The area method of neutron resonance analysis was extended to include the effect of various interference terms which may enter the formula for the neutron resonance cross section. The principal interference term is that between resonance and potential scattering. A series formula was found for the area function which takes account of this term when Doppler broadening is negligible. Doppler broadening is treated by numerical computation. The practical application of these formulas is discussed. Interference caused by other resonances may be important. It can be represented by cross terms between resonances and is treated as a correction to the area function. (auth)

**17677**

NEW VARIATIONAL PRINCIPLE FOR TRANSPORT THEORY. J. Devooght (Univ. of Brussels). Phys. Rev. 111, 665-7(1958) Aug. 1.

A general variational principle of Kahan, Rideau, and Roussopoulos is shown to be applicable to problems of transport theory and in particular to the solution of the Milne problem. The variational principle yields directly the flux at every point, not only at infinity, unlike the classical methods for asymptotic densities. (auth.)

**17678**

MAGNETIC FORM FACTOR OF THE NEUTRON AT 600 MEV. M. R. Yearian and Robert Hofstadter (Stanford Univ., Calif.). Phys. Rev. 111, 934-9(1958) Aug. 1.

The study of electrons scattered inelastically from the deuteron was extended to 600 Mev. Results are presented for seven scattering angles between 45 and 135°. A comparison of the deuteron's cross section at these angles with the corresponding free proton cross sections permits a determination of the form factor associated with the magnetic moment distribution of the neutron. Two different methods of analyzing the data are described, and the rms radius of the neutron for an exponential density distribution of the magnetic cloud can be shown to lie between the limits of $0.75 \times 10^{-13}$ cm and $0.95 \times 10^{-13}$ cm. The rms radius of the neutron may be taken to be $(0.80 \pm 0.10) \times 10^{-13}$ cm and is very close to the value found for an exponential model of the magnetic cloud in the proton. (auth)

**17679**

SEARCH FOR DELAYED NEUTRONS FROM THE PHOTON BOMBARDMENT OF LITHIUM. G. W. Tautfest (Purdue Univ., Lafayette, Ind.). Phys. Rev. 111, 1162-3(1958) Aug. 15.

A search was made for delayed neutrons resulting from the reaction $Li^7(\gamma,2p)H^5$ in an effort to decide whether or not $H^5$ exists. Delayed neutrons were detected in a moderated counter assembly and scaled in nine delay channels which were variable in width and initial delay. A small signal observed after background subtraction showed no decay within statistics over a period of 0.45 sec. The first 0.05-sec counting period

was analyzed for the presence of a decay of 0.01-sec half-life and compared with a predicted yield of the reaction $Li^7(\gamma,2p)$ obtained by extrapolation of the measured yields of the reactions $B^{11}(\gamma,2p)$ and $F^{19}(\gamma,2p)$. The conclusion is that less than one % of the expected $Li^7(\gamma,2p)$ yield can result in a particle stable final state. (auth)

## Nuclear Physics

**17680** AFOSR-TN-58-584
Purdue Univ., Lafayette, Ind.
POLARIZATION OF THE PROTON FROM PHOTODISINTEGRATION OF THE DEUTERON. Masaaki Kawaguchi. [1958]. 23p. Contract AF18(600)-1579. (AD-162104).

The transverse polarization of the outgoing proton from the photodisintegration of the deuteron is calculated in the angular momentum representation, without assuming any detailed interaction among particles. General formulas for the polarization as well as for the angular distribution are given in terms of the Racah coefficients. If the angular distribution is written in a form $a + b \sin^2\theta(1 + 2c \cos\theta)$, the polarization is given in terms of a, b, c, and the nucleon-nucleon scattering phase shifts of the S, P, and D states under reasonable assumptions. By using experimental values of a, b, and c, and scattering phase shifts as much as available and also some theoretical estimates of the phase shifts, 20 to 30% polarization is expected for up to 40-Mev gamma rays and 10 to 20% for 140-Mev gamma rays over a wide range of angles in the center of mass system. (auth)

**17681** UCRL-4630
California. Univ., Livermore. Radiation Lab.
THE RADIUS OF THE SIMPLE TORUS MODEL OF THE ELECTRON AND PROTON. W. H. Bostick. Jan. 1956. 4p. Contract W-7405-eng-48. $1.80(ph OTS); $1.80 (mf OTS).

A torus model is given which yields a value of R for the proton which compares favorably with the value calculated from the hyperfine structure of hydrogen. (A.C.)

**17682**
DETERMINATION OF THE NUCLEAR DIMENSIONS FROM THE FINE STRUCTURE OF THE SPECTRAL LINE AND FROM GAMMA RADIATION. Teofil T. Vescan and Georgeta Sonita. Akad. Nauk Stiint. Univ. Iasi Sec. 1, No. 1-2, 185-90(1955). (Translated from Referat. Zhur. Fiz. No. 5, 1957, Abstract No. 11132.)

**17683**
THE FORM OF THE RELAXATION LAWS IN ELECTRONIC, NUCLEAR, AND QUADRUPOLE RESONANCE. François Lurçat (Univ. of Paris). Ann. phys. 3, 339-76 (1958) May-June. (In French)

The relaxation of a physical system is its evolution toward a state of thermodynamic equilibrium. The phenomena of paramagnetic and nuclear relaxation are studied. The Boltzmann equation which represents the evolution of the system toward equilibrium is derived. The response of the system to an external excitation is also calculated. (J.S.R.)

**17684**
VELOCITY DEPENDENCE OF THE TWO-NUCLEON INTERACTION. S. Okubo and R. E. Marshak (Univ. of Rochester, N. Y.). Ann. Phys. (N. Y.) 4, 166-79(1958) June.

Invariance arguments are used to derive the most general velocity-dependent charge-independent two-nucleon interaction in the nonrelativistic approximation. If one stays on the energy shell, the only essentially new term in the two-nucleon interaction is the quadratic spin-orbit potential. Off the energy shell, the quadratic spin-momentum potential must be treated as independent. In meson theory, the quadratic terms arise as $(\mu/M)^2$ ($\mu$ is the pion mass, M the nucleon mass) corrections to the second-order static potential in contrast to the linear spin-orbit potential which originates as a $(\mu/M)$ correction to the fourth-order static potential. (auth)

**17685**
MESONS AND THE STRUCTURE OF NUCLEONS. PART II. THE NUCLEON ISOBAR AND PION DYNAMICS. Bernard T. Feld (Massachusetts Inst. of Tech., Cambridge). Ann. Phys. (N. Y.) 4, 189-232(1958) June.

An atomic model of the physical nucleons, previously applied to the nucleon ground states, is extended to describe the excited isobar nucleon state, of angular momentum and isotopic spin $3/2$. The model is used to compute the cross sections for resonant photoproduction of pions and Compton scattering of photons on protons. Other, nonresonant processes are taken into account in a phenomenological fashion, and the computed cross sections for the aforementioned processes are compared with available experimental data. The model is also used as a guide for the phenomenological interpretation of other high-energy processes—in particular, photodisintegration of the deuteron in the region of the photomeson threshold, and the resonant $\pi^- - P$ interaction at ~1 Bev. (auth)

**17686**
NEW KNOWLEDGE IN THE FIELD OF ELEMENTARY PARTICLES. W. Braunbek. Atombrief 4, 247-9(1958). (In German)

A brief survey is given of the properties and characteristics of the known nuclear particles. (J.S.R.)

**17687**
POLARIZATION OF NUCLEONS FROM THE DISINTEGRATION OF THE DEUTERON IN THE ELECTROMAGNETIC FIELD OF A NUCLEUS. J. Saivicki. Bull. Acad. Polon. Sci. 3,5, No. 3, 283-9(1957). (Translated from Referat. Zhur. Fiz. No. 1, 1958, Abstract No. 517)

Polarization of nucleons formed upon disintegration of the deuteron in an electromagnetic field of the nucleus was calculated under the assumption that central forces of "zero" radius of action are acting in the deuteron. Polarization is a result of the interference between the magnetic and electric transitions. The calculations are made in the Born approximation, i.e., in the case when $Ze^2/\hbar v_0 \ll 1$.

**17688**
CALCULATIONS OF THE NUCLEAR MAGNETIC SCREENING CONSTANT FOR SOME MOLECULES. I. V. Aleksandrov. Doklady Akad. Nauk S.S.S.R. 121, 823-6(1958) Aug. 11. (In Russian)

Calculational methods for nuclear magnetic screening $\sigma$ based on the method of molecular orbits are adapted for practical evaluation of $\sigma$ magnitude. (R.V.J.)

**17689**
ON THE DISPERSION RELATIONS FOR THE COMPTON EFFECT. A. A. Logunov and A. R. Frenkin (Joint Inst. of Nuclear Research, Dubna, U.S.S.R.). Nuclear Phys. 7, 573-8(1958) Aug.

A basis underlying the deduction of the dispersion relations for the Compton effect on nucleons in the absence of an unobservable energy region is presented. (auth)

**17690**

FIRST ORDER FORBIDDEN $\beta$-$\gamma$ CORRELATION FOR ORIENTED NUCLEI. A. Z. Dolginov and N. P. Popov (Physico-Technical Inst., U.S.S.R. Academy of Sciences, Leningrad). Nuclear Phys. 7, 591-8(1958) Aug.

Explicit formulas for $\beta-\gamma$ correlation of oriented nuclei in first forbidden $\beta$-transitions are obtained. All five types of $\beta$-interaction are considered and the Coulomb field of an extended nucleus is taken into account. Explicit $\beta-\gamma$ correlation formulas for nonoriented nuclei are obtained as a particular case. Angular as well as polarization correlation is considered. (auth)

**17691**

TWO-NUCLEON POTENTIAL FROM CHEW-LOW THEORY. R. T. Sharp (Imperial Coll., London). Nuovo cimento (10) 9, 23-36(1958) July 1.

The two-nucleon potential is derived within the framework of the static cut-off pion theory of Chew and Low. Except for approximations implicit in the original Hamiltonian, the one-meson-exchange potential is exact and agrees, for example, with that of Brueckner and Watson. In the two-meson-exchange potential, scattering effects are treated by the one-meson approximation of Chew and Low. The result is expressed in terms of integrals over the solution of the Low equation. The procedure is indicated for applying the method to certain non-adiabatic effects in the two-nucleon potential, to the $\Lambda$-nucleon potential, and to the three-nucleon force. (auth)

**17692**

NUCLEON STRUCTURE AND PION-PHENOMENA. D. Ito, S. Minami, and H. Tanaka (Univ. of Education, Tokyo, Osaka City Univ., Univ. of Bologna, and Istituto Nazionale di Fisica Nucleare, Bologna). Nuovo cimento (10) 9, 208-27(1958) July 16.

The effect of the nucleon structure is discussed, correlating phenomenologically a variety of pion-nucleon phenomena with the nucleon core. In the high-energy region, the experimental evidence is interpreted in terms of nucleon structure. The main results are: (1) The optical radius R of the proton estimated the $\pi^-$-p elastic scattering is nearly constant in the energy region (1 to 5) Bev; (2) the effective collision parameter in the $\pi^-$-p reaction shows the nearly constant value $0.8 \times 10^{13}$ cm in the (1 to 5) Bev region; (3) the mean energy of the mesons produced in the $\pi^+$-p reaction in the energy range (1 to 5) Bev indicates a picture of meson production as a shaking off of mesons from the nucleon core; (4) in the nucleon-nucleon collisions in Bev order, the mean energy of the mesons produced suggests a shaking off of the external meson cloud such as given by the isobar model; (5) a regularity of the reduced multiplicity is discussed concerning the proton-antiproton annihilation star. In the low-energy region, the well known failure of the meson theory on the S wave is to be ascribed to the internal effect of the nucleon structure. (auth)

**17693**

ON THE CHARGE CONJUGATION OF BARYONS. P. Budini, N. Dallaporta, and L. Fonda (Univ. of Padua and Istituto Nazionale di Fisica Nucleare, Padua). Nuovo cimento (10) 9, 316-23(1958) July 16.

If the baryon is considered as composed of a bare spinor without charge or strangeness and the known meson fields (both $\pi$ and K), one may investigate the behavior of the lagrangian describing this model under an operation which reverses the sign of charge and strangeness of the mesons without altering the bare baryon (boson conjugation B) and an operation which turns the bare baryon into its antiparticle without changing the meson fields (spinor conjugation S), the product of these two operations being the usual charge conjugation C. It is found, when one neglects mass differences between nucleon and hyperons, that the lagrangian of this system is invariant for each of the three operations B, S, and C, separately. The same property is deduced also for the d'Espagnat-Prentki lagrangian of an assembly of real nucleons, hyperons, and mesons and for the interactions with the electromagnetic field of all these particles. Finally, it is suggested that the mass difference between nucleon and $\Xi$ could be due to an interaction term in the lagrangian which should be invariant under charge conjugation but not under the B and S conjugations separately, and a simple proposal for such a term is made. (auth)

**17694**

A GENERAL TYPE OF EXPERIMENTS PROPOSED TO TEST THE CONSERVATION OF PARITY IN STRONG INTERACTIONS AT HIGH ENERGIES. P. G. Sona (Istituto Nazionale di Fisica Nucleare Laboratori Nazionali del Sincrotrone, Frascati, Italy). Nuovo cimento (10) 9, 334-6(1958) July 16.

Experiments are proposed which require only one production interaction and unpolarized primary beams. The experiments can be carried out by studying those reactions between elementary particles resulting in a final state in which three different particles are present. As an example, the reaction $\pi^- + p \rightarrow n + \pi^+ + \pi^-$ is considered. (L.T.W.)

**17695**

A DISCUSSION OF SOME ANGULAR DISTRIBUTIONS IN THE REACTIONS $\pi + N \rightarrow \pi + \pi + N$. $N + N \rightarrow 2N + \pi$, $\gamma + N \rightarrow \pi + \pi + N$. G. Morpurgo (Univ. of Parma, Italy). Nuovo cimento (10) 9, 564-7(1958) Aug. 1.

In presenting data from the reactions, certain angular distributions of the final products should be plotted which may provide valuable information on some significant aspects of the reactions. Two aspects considered in particular are: to know whether or not two of the three outgoing particles have a preference for some relative angular momentum state, and to find evidence for parity conservation. (W.D.M.)

**17696**

TWO-PARTICLE INTERACTIONS IN DEFORMED NUCLEI. Taro Tamura (Univ. of Calif., Los Angeles). Phys. Rev. 111, 859-76(1958) Aug. 1.

Effects of two-particle interactions in deformed nuclei are considered. The deformed nucleus is assumed to be replaced by a set of particles in a cylindrically symmetric harmonic oscillator potential, while the two-particle interaction is assumed to be of $\delta$-function type. Fairly extensive calculations are performed in diagonalizing the interaction energies which exist between particles lying in degenerate levels in the above mentioned potential. The characteristic energies and the explicit form of the eigenfunctions are tabulated. In particular it is noticed that the seniority number is a good quantum number for this sort of interaction. Several important features of the results are discussed, including the matrix elements of the E2 transitions. (auth)

**17697**

SCATTERING OF PROTONS IN A SPIN-ORBIT POTENTIAL. G. W. Erickson and W. B. Cheston (Univ. of Minnesota, Minneapolis). Phys. Rev. 111, 891-7(1958) Aug. 1.

An approximation method is described for treating

spin-orbit potentials in the optical model. The method is essentially a perturbation expansion using exact scattering amplitudes for a central optical potential as the unperturbed scattering amplitudes. The method is compared to an exact calculation and its usefulness in the medium-energy region demonstrated. The effects of a spin-orbit term on the differential cross section and the spin polarization distribution are investigated as a function of the parameters involved in the medium-energy region. The polarization is shown to be approximately independent of the shape of the form factor of the spin-orbit term in this energy region. The reaction cross section is insensitive to the inclusion of a spin-orbit term of reasonable depth. (auth)

**17698**

MULTILEVEL FORMULA FOR THE FISSION PROCESS. C. W. Reich and M. S. Moore (Phillips Petroleum Co., Idaho Falls, Idaho). Phys. Rev. 111, 929-33(1958) Aug. 1.

The dispersion theory formalism of Wigner and Eisenbud was applied to the problem of interference between resonances in the slow-neutron fission cross section. The development presented assumes that the process involves one neutron channel and a large number of channels for the capture process. Although the treatment, for simplicity, assumes that only one fission channel is open, the relevant expressions for the fission cross section are presented in such a form that the generalization to any number of fission channels is readily apparent. Although no restriction as to the number of levels is necessary, the results are of practical use only when the number of assumed fission channels is small. Multilevel expressions for the radiative capture and scattering cross sections are also presented for one fission channel. The radiative capture cross section in the absence of fission is given and shown to differ formally from a sum of single-level Breit-Wigner terms. (auth)

**17699**

APPLICATION TO ELECTRON SCATTERING OF CENTER-OF-MASS EFFECTS IN THE NUCLEAR SHELL MODEL. L. J. Tassie and F. C. Barker (Australian National Univ., Canberra). Phys. Rev. 111, 940(1958) Aug. 1.

The usual shell-model treatment of the nuclear scattering of high-energy electrons neglects the motion of the center of mass of the nucleus. The correction due to this is calculated for the case of an oscillator potential well and gives a simple additional factor multiplying the nuclear form factor. (auth)

**17700**

A NOTE ON CHARGE INDEPENDENCE AND NUCLEON-ANTINUCLEON INTERACTIONS. S. K. Srinivasan (Univ. of Madras, India). Proc. Indian Acad. Sci. A47, 365-8(1958) June.

Some inferences are drawn on nucleon-antinucleon interactions on the basis of charge independence of nuclear forces. (W.D.M.)

**17701**

THE SPIN-ORBIT INTERACTION BETWEEN NUCLEONS AND THE SPIN-ORBIT COUPLING IN THE CAPAS MODEL OF THE NUCLEUS. Marcos Moshinsky (Univ. Nacional Autonoma de Mexico and Instituto Nacional de la Investigacion Cientifica, Mexico). Rev. mex. fis. 7, 95-109(1958). (In Spanish)

The origin of the spin orbit coupling force in nuclei is discussed. Taking the two particle spin orbit potential between nucleons, it is shown that the spin orbit force in nuclei has a strength proportional to the first moment $I_1$ of the potential $\xi$. The value of $I_1$ has been obtained from the experimental data for heavy nuclei by Blin-Stoyle, and it is $I_1 = 141$ Mev $f^5$, ($f = 10^{-13}$ cm). For the two particle spin orbit potential of Gammel and Thaler, $I_1$ is given by $I_1 = -9.44$ Mev $f^5$. For the two particle spin orbit potential of Signell and Marshak, $I_1$ has the value $I_1 = -252$ Mev $f^5$. While neither potential gives the experimental value of $I_1$, the potential of Signell and Marshak gives at least the correct order of magnitude for the spin orbit coupling force required by the nuclear shell model. (auth)

**17702**

THE QUESTION OF DISPERSION RELATIONS FOR REACTIONS WITH VARYING PARTICLE NUMBER. A. A. Logunow, A. N. Tawchelidse, and N. A. Tschernikow (Vereinigten Institut für Kernforschung, Dubna, USSR). Z. Naturforsch. 13a, 642-4(1958) Aug. (In German)

Dispersion relations for the double Compton effect on nucleons ($p + \gamma \rightarrow p + 2\gamma$) are given and possible cases for which the dispersion relations include no non-observable energy range are shown. (tr-auth)

**17703**

DETERMINATION OF THE ENERGY OF FAST PARTICLES FROM THE ANGULAR DISTRIBUTION OF THE REACTION PRODUCTS. A. I. Nikishov and I. L. Rozental (Lebedev Inst. of Physics, Academy Nauk USSR). Zhur. Eksptl'. i Teoret. Fiz. 35, 165-9(1958) July. (In Russian)

The error appearing in energy E determinations of fast colliding particles from the angular distribution of the produced particles is analyzed. It is found that in order to determine the energy with help of this method one should take into account the relation between the total number of observed star tracks and the energy E. The dependence predicted by the Landau theory is employed in the present work. An approximate distribution of E as a function of the angles and number of observed tracks is obtained. (tr-auth)

**17704**

POLARIZATION CORRELATION OF $\beta$-PARTICLES AND $\gamma$-QUANTA IN ALLOWED DECAY OF ORIENTED NUCLEI. A. Z. Dolginov (Leningrad Inst. of Physics and Tech.). Zhur. Eksptl'. i Teoret. Fiz. 35, 178-83 (1958) July. (In Russian)

Formulas are derived for the correlation between the polarization of $\beta$ particles and circular polarization of the subsequent $\gamma$-quanta in allowed $\beta$-decay of oriented nuclei. (tr-auth)

**17705**

$\alpha$-DECAY OF NONSPHERICAL NUCLEI. L. L. Goldin, G. M. Adelson-Velskii, A. P. Birzgal, et al. Zhur. Eksptl'. i Teoret. Fiz. 35, 184-202(1958) July. (In Russian)

A set of equations for radial functions which describe the motion of $\alpha$-particles emitted in the $\alpha$ decay of nonspherical nuclei with arbitrary spins is considered. Formulas are obtained which define the boundary conditions for the radial functions on the nuclear surface and also formulas which express the probability for $\alpha$ decay in terms of the values of the radial functions on the nucleus and of the shape of the nucleus. A simple approximate formula was derived for the dependence of $\alpha$-decay probability on the momentum l carried off by the $\alpha$ particle and on the energy of the daughter nucleus. For even nuclei (spin 0) an analysis is carried out of the various ways of approximate solution of the equation set

for the radial functions. It is shown that the terms which connect the equations (due to the nonspherical part of the Coulomb interaction between the $\alpha$ particle and the nucleus) cannot be regarded as a perturbation for $l > 2$. An exact numerical solution of the equation set is carried out for an elliptic nucleus with account of all multipole interactions, the wave function being assumed constant on the nuclear surface. The significance of higher harmonics is determined in the Legendre polynomial expansion of the equation on the nuclear surface. The results of the calculations are compared with the experiments. (tr-auth)

**17706**

ON THE MOMENT OF INERTIA OF A NONSPHERICAL NUCLEUS. Yu. K. Khokhlov (Lebedev Inst. of Physics, Academy of Sciences, USSR). Zhur. Eksptl'. i Teoret. Fiz. 35, 240-3(1958) July. (In Russian)

The expression for the nuclear moment of inertia proposed by Inglis is computed by the perturbation theory procedure in an approximation including the square of the nonsphericity parameters. For the potential of the independent particle model a square well with infinitely high walls is taken. The calculated moment of inertia of the closed shells exceeds the hydrodynamical value by several times. (tr-auth)

**17707**

ON THE THEORY OF INTERACTION BETWEEN FAST NEUTRONS POSSESSING VARIOUS ANGULAR MOMENTA WITH SEMI-TRANSPARENT NUCLEI. L. E. Pargamanik and V. V. Ulyanov (Kharkov State Univ.). Zhur. Eksptl'. i Teoret. Fiz. 35, 258-64(1958) July. (In Russian)

The participation of fast neutrons with various angular momenta in the interaction with semi-transparent nuclei is studied within the framework of the complex square well nuclear model. The exact expressions for the partial cross sections are approximated with help of special asymptotic formulas for cylindrical functions which are valid throughout the complete angular momentum range. This approximation permits one to determine with greater precision the significance of waves with angular momenta $l \sim kR$ in neutron scattering and absorption processes as compared with the results derived in the quasi-classical approximation. Corrections to the integral absorption and scattering cross sections are obtained which are appreciable at high and low effective absorption. (tr-auth)

**17708**

BREMSSTRAHLUNG AND PAIR PRODUCTION ON PROTONS CONSIDERING THE FORM FACTOR. I. Zlatev and P. S. Isaev (Joint Inst. of Nuclear Research). Zhur. Eksptl'. i Teoret. Fiz. 35, 309-10(1958) July. (In Russian)

The influence of the form factor on bremsstrahlung and pair production in electron-proton scattering processes was calculated with the lowest approximation of the perturbation theory (the third order). (R.V.J.)

**17709**

THE NEUTRINO. James S. Allen. Princeton, N. J., Princeton University Press, 1958. 171p.

A summary of investigations of the neutrino through May 1957 is presented. The experimental method is emphasized, and an attempt is made to interpret the experimental results in terms of existing theories of the neutrino. Sections are offered on the general properties, rest mass, and detection of the neutrino, beta decay, recoil following electron capture, and meson-neutrino reactions. (W.D.M.)

# Nuclear Properties

*Refer also to abstracts 17425 and 17435.*

**17710** AERE-I/R-2630

United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England.

FLUX AND CROSS-SECTION MEASUREMENTS WITH FAST FISSION NEUTRONS IN BEPO AND DIDO. C. E. Mellish, J. A. Payne, and R. L. Otlet. July 1958. 22p. $0.63(BIS).

The neutrons emitted in the fission of $U^{235}$ by thermal neutrons vary in energy from about 15 Mev to zero. This means that the problem of measuring fast flux and fast neutron reaction cross sections by a simple activation method is inherently complicated by the fact that the activity produced in a sample can be influenced by distortions of the fission spectrum in the moderator of the reactor. No absolute calibration of fast fluxes has been performed in this investigation; all the results are based on the figure of 30 mb for the cross section of the reaction $S^{32}(n,p)P^{32}$ obtained by Hughes. Hughes has measured a number of cross sections of (n,p) and $(n,\alpha)$ reactions for fission neutrons and has shown that these can be roughly accounted for by consideration only of nuclear size and penetrability. It is assumed that the collision cross section for fast neutrons is the nuclear area and that the chance of the compound nucleus breaking up to give a proton, or $\alpha$ particle, is simply proportional to the penetrability of the compound nucleus. This is calculated from the energy balance of Bethe's formula. Hughes measured cross sections of these reactions for elements from Be to V. Cross sections have been measured for several elements between Tl and Mo, and also the cross sections of the reaction $Tl^{203}(n,p)Hg^{203}$ and $Cs^{133}(n,\alpha)I^{130}$, in an attempt to see how far up the periodic table (n,p) and $(n,\alpha)$ reactions are detectable. The cross sections determined are tabulated. (A.C.)

**17711** APEX-407

General Electric Co. Aircraft Nuclear Propulsion Dept., Cincinnati.

GAMMA RAY ENERGY SPECTRA FROM THERMAL NEUTRON CAPTURE. F. E. Deloume. Aug. 1958. 48p. Contracts AF33(038)-21102 and AT(11-1)-171. $1.50(OTS).

Energy spectra of gamma rays resulting from thermal neutron capture are compiled for 48 elements. The data are presented in both graphical and tabular form. Thermal-neutron-capture cross sections, isotopic abundances, binding energies of the extra neutron in the isotopes, and weighted-average binding energies are also tabulated. (auth)

**17712** UCRL-5226(Pt.I(Vols.I-III))

California. Univ., Livermore. Radiation Lab.

TABULATED NEUTRON CROSS SECTIONS. PART I. 0.001–14.5 MEV. Volume I. $_{1}H-_{22}Ti$. Volume II. $_{23}V-_{50}Sn$. Volume III. $_{51}Sb-_{95}Am$. Robert J. Howerton. May 1958. (Vol. I, 422p.; Vol. II, 404p.; Vol. III, 287p.) Contract W-7405-eng-48. Vols. I and II, $6.00 (OTS); Vol. III, $4.00(OTS).

These three volumes were issued separately, but are cataloged as a unit.

Tables of neutron cross sections are presented which represent a major portion of all reported experimental data. Data for total and reaction cross sections for all isotopes in the energy range 0.001 to 14.5 Mev are included. Data were collected from journals, AEC reports, and private communications with experimenters.

References are included. A loose-leaf binding is provided in order that additional information presented in planned annual addenda may be inserted. A subsequent part extending the energy range and another containing differential cross sections is intended. (D.E.B.)

**17713**

ON THE RADIOACTIVE DEPOSITS OF THORON. Hirotoshi Sano (Univ. of Tokyo). Bull. Chem. Soc. Japan 31, 662-3(1958) July.

The disintegration products of thoron collected on copper plate, polyethylene film, and water were studied. The experimental methods are described, and the results are discussed and presented graphically. (J.R.D.)

**17714**

NEUTRON CAPTURE CROSS SECTION OF $I^{129}$ AND $I^{130}$ J. C. Roy and D. Wuschke (Atomic Energy of Canada Ltd., Chalk River, Ont.). Can. J. Chem. 36, 1424-30 (1958) Oct.

The capture cross section of $I^{129}$ for 2200 m/sec neutrons and its resonance capture integral were determined by counting the beta rays emitted by the 12.5-hour $I^{130}$ formed by an $(n,\gamma)$ reaction on $I^{129}$. The $\sigma_{2200}$ was found to be 26.7 ± 2.0 barns and the resonance capture integral 36 ± 4.0 barns. The effective capture cross section of $I^{130}$ for reactor neutrons was measured to be 1.80 ± 3.0 barns by counting the beta rays emitted by the 8.1-day $I^{131}$ produced by successive neutron capture in $I^{129}$. The neutron fluxes were measured with cobalt monitors; the thermal cross section and the resonance capture integral of $Co^{59}$ were taken to be 36.5 and 48.6 barns. (auth)

**17715**

NEUTRON MULTIPLICATION IN SMALL SPHERES OF FISSIONABLE MATERIAL. P. J. Bendt and R. E. Peterson (Los Alamos Scientific Lab., N. Mex.). J. Appl. Phys. 29, 1271-7(1958) Sept.

Central-source neutron multiplication measurements have been made on small spheres of $U^{233}$, $U^{235}$, $U^{238}$, and $Pu^{239}$. Measurements were made on four sizes of spheres, varying approximately from 1 in. to 2.5 in. in diameter. In the case of $U^{233}$, only one sphere, 1.245 in. in diameter, was available. The three neutron sources, mock-fission, Po–Li, and Po–Be, were 0.4-in. diameter spheres. They have widely different neutron spectra. Multiplications were measured with a flat-response long counter, and with $U^{235}$, $U^{238}$, and $Np^{237}$ spiral fission chambers, under conditions such that the error introduced by room-scattered neutrons was negligible. Results of the multiplication measurements are given. The measurements have been analyzed to obtain the leakage spectra from the spheres in terms of three velocity groups. The $Np^{237}$ and $U^{238}$ fission chambers serve as threshold detectors defining the lower energy of the second and third velocity groups, respectively. (auth)

**17716**

THERMAL NEUTRON ABSORPTION CROSS SECTION OF XENON-124. J. M. Tobin and J. H. Sako (General Electric Co., Richland, Wash.). J. Appl. Phys. 29, 1373(1958) Sept.

The thermal neutron absorption cross section of $Xe^{124}$ was found by the activation analysis method to be 74.4 b. (L.T.W.)

**17717**

A NEW HOLMIUM ACTIVITY, $^{159}Ho$. Kenneth S. Toth (Univ. of California, Berkeley). J. Inorg. & Nuclear Chem. 7, 1-4(1958) Aug.-Sept.

A new activity, $Ho^{159}$, has been produced by an $(\alpha,4n)$ reaction on stable terbium. The nuclide decays primarily by electron capture with a half-life of 33 min. Evidence has been found to support the proposal by Mihelich and co-workers that the ground state of $Ho^{159}$ is short-lived compared to its metastable state whose half-life is 5 hr. The half life of the ground state seems to be about 28 min. (auth)

**17718**

DECAY SCHEME OF 2:1 hr $^{178}Ta$. F. F. Felber, Jr., F. S. Stephens, Jr., and Frank Asaro (Univ. of California, Berkeley). J. Inorg. & Nuclear Chem. 7, 153-6(1958) Aug.-Sept.

$Ta^{178}$ decays by electron capture, with a small positron branching to stable $Hf^{178}$. The methods of preparing and purifying the $Ta^{178}$ are discussed, and the method of deducing the decay scheme is described. (J.R.D.)

**17719**

THE SLOW NEUTRON TOTAL CROSS-SECTION OF $^{143}Nd$. H. J. Hay (Atomic Energy Research Establishment, Harwell, Berks, Eng.). J. Nuclear Energy 7, 199-204(1958) Sept.

Crystal spectrometers covering the energy range 0.01 to 10 ev were used to measure the transmission of neodymium oxide enriched in the isotope $Nd^{143}$. Analysis of the energy dependence of the $Nd^{143}$ total cross-section gives the 2200 m/sec cross-sections as 335 ± 20 b for absorption and 75 ± 7 b for scattering, and the parameters of a negative energy resonance are $E_0 = -6 \pm 1$ ev, $\Gamma_\gamma = 86 \pm 15$ mv, $\Gamma_n^0 = 68 \pm 15$ mv. (auth)

**17720**

THE RATIO OF THE $(n,\gamma)$ TO $(n,2n)$ CROSS-SECTION FOR THORIUM-232 BOMBARDED WITH FISSION NEUTRONS. R. A. Hasse, P. Kafalas, and R. R. Heinrich (Argonne National Lab., Lemont, Ill.). J. Nuclear Energy 7, 205-9(1958) Sept.

Thorium-232 was exposed to an unmoderated neutron flux produced by uranium-235 fission. The ratio of the integrated cross-sections for the $(n,\gamma)$ and $(n,2n)$ reactions $[\bar{\sigma}(n,\gamma)/\bar{\sigma}(n,2n)]$ was determined to be 11.3 ± 0.3. (auth)

**17721**

LEVELS AND BRANCHING RATIOS IN $Tb^{159}$. K. O. Nielsen, O. B. Nielsen, and O. Skilbreid (Univ. of Copenhagen). Nuclear Phys. 561-8(1958) Aug.

$\beta$-ray sources of $Gd^{159}$ were prepared in an electromagnetic isotope separator. The decay scheme $Gd^{159} \rightarrow Tb^{159}$ was reinvestigated in two six-gap $\beta$-ray spectrometers. $\gamma$-ray spectra coincident with $\beta$ rays and conversion lines were recorded on a 100 channel analyzer. Three $\gamma$-transitions of ≈ 225, ≈ 300, and 364 kev from the 364 kev level to the ground state rotational band were observed, and it was confirmed that the relative intensities disagree with the theoretical branching ratios. It is suggested that the deviation is connected with the fact that the $\gamma$-rays are of E1 nature and probably strongly hindered. (auth)

**17722**

THE LOW ENERGY NEUTRON RESONANCES OF BISMUTH. J. E. Lynn, M. C. Moxon, and F. W. K. Firk (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Nuclear Phys. 7, 613-21(1958) Aug.

The neutron transmission of bismuth was measured as a function of neutron energy between 300 ev and 4000 ev for samples of different thickness. The resonance at 784 ± 9 ev may be described by the combinations of parameters $\sigma_0 a_R^2/\lambda_R^2 = 5.68 \pm 0.22$ barn, $\Gamma\lambda_R/a_R = 77.4 \pm 3.3$ ev, and the resonance at 2230 ± 40 ev by $\sigma_0 a_R^2/\lambda_R^2 = 3.78 \pm 0.20$ barn and $\Gamma\lambda_R/a_R = 196 \pm 11$ ev. The interpretation of these results is that the two resonances

correspond to states of the compound nucleus of different total angular momentum J. Hence the effective potential scattering cross section in the region 0–3 kev averages 9.46 ± 0.3 barn. The probable spins of the two resonances are J = 5 for the 784 ev resonance and J = 4 for the 2230 ev resonance and the widths, Γ, are 4.34 ± 0.15 ev and 16.6 ± 0.7 ev respectively. This interpretation implies that the spin of the large resonance observed at about 12 kev by other workers is J = 4 and its width is ≈ 400 ev. The true potential scattering cross section then turns out to be approximately 10.4 ± 0.3 barn. (auth)

**17723**

CROSS SECTIONS. Nucleonics 16, No. 9, 107, 126, 128(1958) Sept.

The cross section data presented at Geneva on thermal cross sections, resonance parameters, partial cross sections, and prediction from theory are surveyed. (J.S.R.)

**17724**

ENERGY SPECTRA OF PHOTONEUTRONS FROM Cr AND Ta. G. Cortini, C. Milone, A. Rubbino (Univ. of Catania, Italy, and Centro Siciliano di Fisica Nucleare, Catania, Italy), and F. Ferrero (Univ. of Turin and Istituto Nazionale di Fisica Nucleare, Turin). Nuovo cimento (10) 9, 85-98(1958) July 1.

The energy spectra of photoneutrons emitted at 90° by Cr and Ta under bremsstrahlung of 20 and 30 Mev are investigated by means of the recoil protons in photoemulsion. A scanning method was followed, which gives some advantage for the study of the high energy tail of the spectra. The interpretation of the second maximum on the ground of a quasi-deuteron absorption process seems to be excluded. An explanation of experimental results is discussed. (auth)

**17725**

HYPERFINE STRUCTURE OF THE METASTABLE STATE OF SINGLY IONIZED HELIUM-3. Robert Novick and Eugene D. Commins (Columbia Univ., New York). Phys. Rev. 111, 822-40(1958) Aug. 1.

The hfs splitting $\Delta\nu$ of the metastable state of singly ionized helium-3 is determined by an ion-beam method. The conventional inhomogeneous molecular-beams A and B fields are replaced by radio-frequency fields at 13,350 Mc/sec. At this frequency transitions are preferentially induced between the F = 1 component of the $2\ ^2S_{1/2}$ state and the short-lived $2\ ^2P_{1/2}$ state. All those ions which have made the transition decay immediately to the ground state. Thus, as the beam passes through such a field, state-selection is accomplished by selective quenching of the F = 1 metastable ions. Two types of detection were used: photoelectric detection of the Lyman-alpha photons emitted in the second state selector, and metastable ion detection by the surface Auger effect. Eighty-six determinations of the hfs splitting were made under a range of experimental conditions. The final result is $\Delta\nu$ = 1083.35499 ± 0.00020 Mc/sec. This value is compared with the theoretical hfs splitting for a point nucleus, which includes the known electrodynamic, relativistic, and reduced-mass corrections, and which may be computed precisely, since the atomic wave function of $He^{3+}$ is hydrogenic and known exactly. The observed hfs splitting is smaller by 186 ppm than the theoretical value. This anomaly is attributed to the effects of finite nuclear and nucleon size, higher order radiative effects, and possibly also to nuclear interaction currents. Estimates are made of some of these effects. The hfs splitting $\Delta\nu(1s)$ of the ground state of $He^{3+}$ is estimated on the basis of the present result to be $\Delta\nu(1s)$ = 8665.628 ± 0.013 Mc/sec. The experimental result is also compared with the experimentally determined hfs splitting of the 1s2s ($^3S_1$) state of the $He^3$ atom. The ratio of these two quantities yields a precise estimate of the electronic charge density at the nucleus of the $2\ ^3S_1$ state of the $He^3$ atom. The monoenergetic nature of the ion beam has allowed observation of a new molecular beams resonance power sharpening effect. (auth)

**17726**

GAMMA RAYS FROM $I^{128}$. H. Bosch, R. Radicella, P. Reyes, and T. Urstein (Comisión Nacional de Energía Atómica, Buenos Aires). Phys. Rev. 111, 898-900(1958) Aug. 1.

The gamma radiation following the decay of $I^{128}$ was studied by means of a single-channel analyzer. Four gamma rays of energies 0.445, 0.530, 0.740, and 0.975 Mev and relative intensities 100 : 9.3 : 0.9 : 1.8 were found. Three methods of preparing the source were employed in order to check the purity of the sample. Using published data together with the results, a level sequence is proposed for $Xe^{128}$, which is of vibrational type. (auth)

**17727**

VARIATIONS IN SPECTRA OF RESONANCE NEUTRON CAPTURE GAMMA RAYS IN INDIUM. J. E. Draper, C. A. Fenstermacher, and H. L. Schultz (Yale Univ., New Haven, Conn.). Phys. Rev. 111, 906-12(1958) Aug. 1.

Measurements are reported of the 0 to 350 kev portion of the gamma-ray spectra following neutron capture in the 1.46-, 3.86-, and 9.10-ev resonances of the $_{49}In^{115}$ target nucleus. The prominent features of the spectra are significantly different for the three resonances as indicated by the ratios of relative intensities of the 67-, 98-, 188-, and 280-kev gamma rays. The 0 to 1600 kev portion of the spectrum following thermal neutron capture is presented. The absolute intensity of the 280-kev gamma ray was measured for the three resonances. (auth)

**17728**

STUDIES OF DECAY SCHEMES IN THE OSMIUM-IRIDIUM REGION. I. ISOMERS $Os^{190m}$ (10 MIN) AND $Os^{189m}$ (5.7 HR). G. Scharff-Goldhaber, D. E. Alburger, G. Harbottle, and M. McKeown (Brookhaven National Lab., Upton, N. Y.). Phys. Rev. 111, 913-19(1958) Aug. 1.

While the decay-scheme of the even-even isomer $Os^{190m}$(10 min) has some similarity with that of the "rotational" isomer $Hf^{180m}$, it differs from the latter in that $Os^{190}$ lies in the transition region between the nuclei with rotational and those with near-harmonic level schemes. It was previously believed that the lifetime determining transition in $Os^{190m}$ was a 620-kev transition followed by three lower energy gamma rays. It is found, however, that the isomeric transition is a previously overlooked 38.4-kev M2 transition with an $|M|^2 = 2.6 \times 10^{-9}$ ("K forbidden"). It is followed by four successive γ rays. Internal conversion electron studies by means of an intermediate image spectrometer yielded γ-ray energies of 187 ± 1, 359 ± 2, 500 ± 3, and 614 ± 3 kev. All four transitions are of electric quadrupole character, suggesting that the levels populated are 8+, 6+, 4+, 2+, 0+ (ground state). Delayed coincidence measurements by A. W. Sunyar show that the two lowest energy transitions of 359 and 187 kev take place between the levels 4+ → 2+ and 2+ → 0+ respectively and it may be expected that also the two higher energy γ rays follow each other in the order of decreasing en-

ergy. However, in contrast to the level spacings in true rotational nuclei, the level energies are far from being proportional to $I(I+1)$, and cannot even be represented with the help of a correction term $\sim I^2(I+1)^2$. The six-hour osmium isomer, which was discovered by T. C. Chu and assigned by him to $Os^{190m}$, was identified instead as $Os^{189m}$. The half-life was found to be 5.7 ± 0.1 hour. The isomer decays by a 30.0-kev M3 transition to the ground state with $|M|^2 = 2.2 \times 10^{-5}$. (auth)

**17729**

RADIATIONS OF OSMIUM-193 AND OSMIUM-191. V. S. Dubey, S. S. Malik, C. E. Mandeville, and Ambuj Mukerji (Franklin Inst., Swarthmore, Penna.). Phys. Rev. 111, 920-4(1958) Aug. 1.

The radiations of $Os^{193}$ and $Os^{191}$ were examined in a thin-lens beta-ray spectrometer and in coincident scintillation spectrometers. Ten gamma rays and seven beta spectra were detected in the decay of $Os^{193}$, revealing energy levels in $Ir^{193}$ at 73, 138, 356, 388, 458, and 558 kev. In order of decreasing end-point energy, the relative intensities of the beta spectra of $Os^{193}$ are estimated as 67, 6, 4, 2, 3, 13, and 5. The beta-ray spectrum of $Os^{191}$ was observed, and the K/L ratio of the 129-kev transition of $Os^{191}$ was measured as 2.4, corresponding to a mixture of 54% E2 in M1. (auth)

**17730**

Λ-NUCLEON INTERACTION IN THE HYPERNUCLEUS $_{\Lambda}Be^9$. Kiu S. Suh (Cornell Univ., Ithaca, N. Y.). Phys. Rev. 111, 941-3(1958) Aug. 1.

A variational method was used to calculate the strength of the Λ-nucleon interaction required to account for the observed binding of $_{\Lambda}Be^9$. The hypernucleus is treated as a three-body system (two alpha particles and the hyperon), in which the spin-average of the Λ-nucleon interaction is effective. Results in agreement with previous calculations of the Λ-nucleon interaction in $_{\Lambda}He^5$ are obtained without appreciable overlapping of the two alpha particles. This absence of overlapping is taken to be a reasonable criterion for the validity of the model. (auth)

**17731**

HYPERNUCLEAR BINDING ENERGIES AND THE Λ-NUCLEON INTERACTION. R. H. Dalitz (Univ. of Chicago) and B. W. Downs (Cornell Univ., Ithaca, N. Y.). Phys. Rev. 111, 967-86(1958) Aug. 1.

A phenomenological analysis is made of the binding-energy data for light hypernuclei in terms of a two-body Λ-nucleon interaction, in which account is taken of the empirical information available on the structure of light nuclei. It is found that the observed binding energies can be interpreted in terms of a spin-dependent Λ-nucleon interaction; the agreement obtained is adequate for any force-range between $0.4 \times 10^{-13}$ cm and $0.7 \times 10^{-13}$ cm (for Yukawa shape) and any exchange character for this interaction. From observations on $_{\Lambda}H^4$ decay it is argued that the $_{\Lambda}H^4$, $_{\Lambda}He^4$ doublet has zero spin, which requires that the singlet Λ-nucleon interaction be more attractive than the triplet. The well-depth parameter for the singlet Λ-nucleon interaction has values from 0.90 to 0.85 for ranges between $0.4 \times 10^{-13}$ cm and $0.7 \times 10^{-13}$ cm, the triplet interaction being also attractive but only one-half to one-third as strong. Spin values are assigned to the light hypernuclei, and the angular correlations which could provide a check on these values are discussed. The absorption of $K^-$ mesons in helium is discussed; it appears that the selection rules for the production of A = 4 hypernuclei in this reaction may be confused by the existence of an excited state $_{\Lambda}H^{4*}$, $_{\Lambda}He^{4*}$. A number of uncertainties in the phenomenological analysis of the heavier hypernuclei are pointed out; the present data do not disagree with the conclusions based on the analysis of the lighter and better-known hypernuclei with A ≤ 5, but they add little weight to these conclusions. (auth)

**17732**

ANISOTROPY ENERGY IN $MnF_2$ AT LOW TEMPERATURES. Takehiko Oguchi (Univ. of Pittsburgh). Phys. Rev. 111, 1063-6(1958) Aug. 15.

The anisotropy energy in $MnF_2$ is calculated by spin-wave method. The magnetic dipole interactions and the interactions of individual ions with their surrounding crystalline fields give the anisotropy energy of $-4.9 \times 10^6$ erg/cc at 0°K. The experimental value extrapolated to 0°K by Foner is $-5.0 \times 10^6$ erg/cc. The temperature dependence of the anisotropy energy is obtained as $E_{an}(T)/E_{an}(0) = [M(T)/M(0)]^{2.9}$, where $E_{an}(T)$, M(T) are the anisotropy energy and the magnetization of the sublattice at T°K, respectively, and $E_{an}(0)$, M(0) are the corresponding values at 0°K. (auth)

**17733**

SPIN OF NEPTUNIUM-238. R. G. Albridge, J. C. Hubbs, and R. Marrus (Univ. of California, Berkeley). Phys. Rev. 111, 1137-9(1958) Aug. 15.

The atomic-beam magnetic-resonance method was used to investigate 2.10-d $Np^{238}$ in the low-field or Zeeman region of hyperfine structure. The spin of this nuclide is found to be 2. (auth)

**17734**

NEUTRON NONELASTIC CROSS SECTIONS AT 21.0, 25.5, AND 29.2 Mev. Malcolm H. MacGregor, William P. Ball, and Rex Booth (Univ. of California, Livermore). Phys. Rev. 111, 1155-62(1958) Aug. 15.

Neutron nonelastic collision cross sections for eleven elements were measured in the energy range 21 to 29 Mev. Corrections were applied to the data by means of a UNIVAC calculation. Since no experimental neutron angular distributions are available in this energy region, optical-model calculations were used for the correction problem. In general the cross sections at 25 Mev are 10 to 20% lower than at 14 Mev. (auth)

**17735**

GAMMA RAYS OF $Rh^{106}$(130 ± 2 min). S. Mayo and S. J. Nassiff (Comision Nacional de Energia Atomica, Buenos Aires). Phys. Rev. 111, 1140-1(1958) Aug. 15.

The gamma-ray spectrum of $Rh^{106}$ (130 min) was studied with a NaI(Tl) crystal scintillation spectrometer of 9% resolution for the 662-kev gamma line of $Cs^{137}$. The following gamma rays were obtained: 220 ± 5 kev (18%), 435 ± 5 kev (43%), 515 ± 5 kev (100%), 610 ± 5 kev (26%), 735 ± 5 (36%), 820 ± 5 kev (45%), 940 ± 10 kev (?), 1070 ± 5 kev (40%), 1225 ± 5 kev (23%), 1380 ± 10 kev (?), 1555 ± 5 kev (23%), 1760 ± 10 kev (7%), 1860 ± 10 kev (8%), 2090 ± 10 kev (1%), 2260 ± 10 kev (1%). The measured half-life was 130 ± 2 min. (auth)

**17736**

UPPER LIMIT TO THE MAGNETIC MOMENT OF $He^6$. E. D. Commins and P. Kusch (Columbia Univ., New York). Phys. Rev. Letters 1, 208-9(1958) Sept. 15.

An experiment is described in which an attempt is made to place an upper limit on the nuclear magnetic moment of $He^6$. It is concluded that the spin of the $He^6$ nucleus is zero. (W.D.M.)

**17737**

QUADRUPOLE MOMENT OF $Ne^{21}$. G. M. Grosof, P. Buck, W. Lichten, and I. I. Rabi (Columbia Univ.,

New York). Phys. Rev. Letters 1, 214-15(1958) Sept. 15.

A hyperfine structure intervals in the metastable $(2p)^5(3s)$, $^3P_2$ state of $Ne^{21}$ were measured by the atomic-beam resonance method. The apparatus is the same as that used in the experimental determination of the spin of $Ne^{21}$, although extensive modifications were necessary to obtain an adequate signal-to-noise ratio. (W.D.M.)

**17738**

INDIRECT NUCLEAR SPIN-SPIN INTERACTIONS IN PURE QUADRUPOLE RESONANCE SPECTRA. R. G. Barnes and R. A. Hultsch (Iowa State Coll., Ames). Phys. Rev. Letters 1, 227-8(1958) Oct. 1.

Using a regenerative spectrometer and lock-in detection, the quadrupole resonance spectra of $TlCl_3$ and $HgCl_2$ were examined. No observable effects were found, consistent with theoretical estimates based on the valence-bond model of Itoh and Kambe extended to the case that the bonding wave function possesses considerable ionic character. (W.D.M.)

**17739**

NEUTRON THRESHOLD MEASUREMENTS USING THE CHALK RIVER TANDEM VAN DE GRAAFF ACCELERATOR. H. E. Gove, J. A. Kuehner, et al. (Atomic Energy of Canada, Ltd., Chalk River, Ont.) and P. H. Rose, R. P. Bastide, et al. (High Voltage Engineering Corp., Burlington, Mass.). Phys. Rev. Letters 1, 251-3(1958) Oct. 1.

As part of the program to test the operating characteristics of the Tandem Van de Graaff accelerator, neutron threshold measurements were made on $P^{31}(p,n)$, $Ni^{60}(p,n)$, and $Ni^{58}(p,n)$ in the proton energy range 1.8 to 10.5 Mev. (W.D.M.)

**17740**

$F^{18}$ LEVELS NEAR 1 Mev. J. A. Kuehner, E. Almqvist, and D. A. Bromley (Atomic Energy of Canada, Ltd., Chalk River, Ont.). Phys. Rev. Letters 1, 260-2(1958) Oct. 1.

Evidence is presented for a new level in $F^{18}$ which resolves the apparent discrepancies between measurements in different laboratories on the $F^{18}$ spectrum in the region of 1 Mev excitation. Two levels in the $O^{16}(He^3,p\gamma)F^{18}$ were measured at energies of 0.94 and 1.08 Mev. (W.D.M.)

**17741**

ON THE FIRST EXCITED LEVELS OF $^{190}Os$ ($11^d$). F. Cappellani, U. Farinelli, F. Ferrero, and R. Malvano (Univ. of Turin and Istituto Nazionale di Fisica Nucleare, Turin). Physica 24, 765-6(1958) Sept.

Angular correlations between the two gamma rays of about 360 and 186 kev in the decay of $Ir^{190}$ were measured. The methods are described, and the gamma transitions are listed and discussed. (J.R.D.)

**17742**

THE HALF-LIFE OF THE 8.42 kev STATE OF 169 THULIUM. H. Beekhuis and H. de Waard (Natuurkundig Laboratorium der Rijksuniversiteit, Groningen, Netherlands). Physica 24, 767-8(1958) Sept.

A half life of $(37 \pm 5) \times 10^{-10}$ seconds was found for the 8.42-kev level in $Tm^{169}$, excited in the electron-capture decay of $Yb^{169}$. Arrangement of the detectors is shown, and the method of half-life determination is described. (J.R.D.)

**17743**

NUCLEON-DEUTERON SCATTERING WITH TENSOR FORCES. B. H. Bransden (The University, Glasgow) and K. Smith and C. Tate (University Coll., London). Proc. Roy Soc. (London) A247, 73-91(1958) Sept. 9.

The theory of the elastic scattering of neutrons or protons by deuterons is formulated. It is assumed that the two-body interaction is a mixture of central and tensor components, and the resonating group method is used to derive coupled integro-differential equations for the wave functions of relative nucleon-deuteron motion. The differential cross-section is expressed in terms of eigenphase shifts and mixing parameters, which may be calculated from the asymptotic form of the solutions of these equations. (auth)

**17744**

ON THE DECAY SCHEME OF $Mo^{99}$. I. V. Estulin, G. M. Chernov, and Z. V. Pastukhova (Moscow State Univ.). Zhur. Eksptl'. i Teoret. Fiz. 35, 71-7(1958) July. (In Russian)

The angular correlation of 742 to 180 kev $\gamma$-quanta emitted in the decay of $Mo^{99}$ was measured. By chemical separation of $Tc^{99m}$ it is proved that the $\beta$ transition in $Mo^{99}$ with $E_\beta = 1.23$ Mev leads to an isomer level in $Tc^{99}$ and $(7 \pm 1)\%$ of the 140 kev $\gamma$-quantum intensity is not related to the isomeric transition. Arguments are presented which speak in favor of the following characteristics of the ground state of $Mo^{99}$ $3/2^+$ and of the excited states of $Tc^{99}$ of 922 kev energy: $3/2^+$ or $5/2^-$ and for the 180 kev energy: $7/2^+$. (tr-auth)

**17745**

ON THE POSSIBILITY OF DETERMINING THE INTERACTION CONSTANTS FROM EXPERIMENTS ON $K_{\mu 3}$-DECAY. I. G. Ivanter (Inst. of Scientific Information, Academy of Sciences, USSR). Zhur. Eksptl'. i Teoret. Fiz. 35, 111-15(1958) July. (In Russian)

Expressions for the spectra and polarization of $\mu$ mesons created in $K_{\mu 3}$ decays were obtained for fixed $\pi$-meson energies and arbitrary complex interaction functions. It is shown that within satisfactory accuracy, one can determine from measurements of the spectra and three polarizations all interaction functions except the second vector, one which, under the conditions of the given experiments, cannot be separated from that of the first vector and scalar interaction functions. The presence of tensor interaction can be ascertained from measurements on the spectrum and polarizations of $\mu$ mesons near an energy close to the maximal value. (tr-auth)

**17746**

NUCLEAR ISOMERISM AND ATOMIC SPECTRA. R. Vainer (Inst. of Physics, Academy of Sciences, Rumanian SSR). Zhur. Eksptl'. i Teoret. Fiz. 35, 284-6(1958) July. (In Russian)

The prediction made for the nuclear isomeric shift of the $In^{115}$ (III) spectrum is generalized for all odd-odd nuclei with the following assumptions: (1) In accordance with the nuclear shell model the nuclear transitions are single transitions; (2) In nuclei with optic protons the shift is related to Coulomb interactions, in nuclei with optic neutrons the shift is related to electron–neutron interactions; (3) In the initial approximation the effect is described by the perturbation theory, the "unperturbed" electron wave functions are calculated for the even distribution of the charge over the volume of the nucleus. (R.V.J.)

**17747**

NUCLEAR MAGNETIC RESONANCE SHIFT IN MOLYBDENUM. S. I. Aksenov (Lebedev Inst. of Physics, Academy of Sciences, USSR). Zhur. Eksptl'. i Teoret. Fiz. 35, 300-1(1958) July. (In Russian)

The nuclear magnetic resonance shift conditioned by electron conduction paramagnetism (Knight shift) was measured for $Mo^{96}$ and $Mo^{97}$ in aqueous solutions of $K_2MoO_4$. (R.V.J.)

## Nuclear Reactors

*Refer also to abstracts 17106, 17143, 17145, 17146, 17147, 17292, 17297, 17300, 17302, 17312, 17314, 17321, 17324, 17325, 17330, 17338, 17339, 17342, 17343, 17344, 17346, 17347, 17348, 17349, 17354, 17355, 17356, 17357, 17366, 17375, 17377, 17380, 17381, 17382, 17383, 17384, 17385, 17387, 17389, 17390, 17401, 17403, 17404, 17405, 17407, 17408, 17409, 17413, 17415, 17416, 17417, 17418, 17419, 17423, 17426, 17427, 17428, 17429, 17430, 17431, 17433, 17438, 17948, 17950, 17951, 17952, 17953, 17955, 17956, 17957, 17958, 17959, and 17960.*

**17748** AECU-3827
Illinois Inst. of Tech., Chicago. Armour Research Foundation.
THE ARMOUR DUST FUELED REACTOR (ADFR). Quarterly Progress Report No. 1 for the Period February 21, 1958 to May 21, 1958. W. E. Loewe and D. Krucoff. 47p. ARF Project No. A-115. Contract AT(11-1)-603. $7.80(ph OTS); $3.30(mf OTS).

Work has begun on the ADFR, a reactor using a new fuel form—fissionable dust carried in an inert gas. Temperatures in the range 2,000 to 3,000°F appear feasible in an all-ceramic system. Experimental study of the fuel form was initiated, and a loop to circulate the fuel dust was constructed. Initial operation is encouraging. Theoretical studies were carried on in the areas of reactor physics, heat transfer, and safety. (auth)

**17749** AECU-3828
Illinois Inst. of Tech., Chicago. Armour Research Foundation.
THE ARMOUR DUST FUELED REACTOR (ADFR). Quarterly Progress Report No. 2 For the Period May 21, 1958 to August 21, 1958. W. E. Loewe and D. Krucoff. 23p. ARF Project A-115. Contract AT(11-1)-603. $4.80(ph OTS); $2.70(mf OTS).

Study of the ADFR concept included experimental work on fuel dust suspension stability and redispersibility, erosion, and dust deposition using the fuel dust circulation loop. Some theoretical work was done in the areas of reactor safety and breeding. (For preceding period see AECU-3827.) (auth)

**17750** AECU-3837
Westinghouse Electric Corp. Bettis Plant, Pittsburgh.
PRODUCT SPECIFICATION FOR PWR CORE 1 BLANKET FUEL ROD BUNDLE. J. E. Sharbaugh. Sept. 5, 1958. 9p. (AP-292570(Rev.1)). $1.80(ph OTS); $1.80 (mf OTS).

The fuel rod bundle is a welded assembly of 120 fuel rods and two supporting tube sheets. Each fuel rod contains 26 $UO_2$ pellets. Product and fabrication specifications for these bundles are given. (D.E.B.)

**17751** AERE-MR/R-2529
United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England.
THE BEHAVIOUR OF SOLUBLE SLURRIES FLOWING UNDER A THERMAL GRADIENT. R. I. Hawes, G. W. Horsley, and R. Sheldon. May 1958. 21p. $1.44(BIS).

The behavior of two soluble slurry systems, thorium bismuthide—bismuth and ammonium oxalate—water, flowing under a thermal gradient was examined. Because of crystal growth and plugging it is not considered feasible to operate such systems either as fuel or blanket media in a nuclear reactor unless irradiation effects modify the solubility or other factors. These possibilities were not examined. (auth)

**17752** AERE-R/M-168
United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England.
A MEASUREMENT OF THE CONTRIBUTION OF THE DOPPLER EFFECT TO THE TEMPERATURE COEFFICIENT OF REACTIVITY IN A FAST REACTOR. A. R. Baker and T. A. J. Jaques. June 1958. 26p.

The Doppler effect in $U^{235}$ and $U^{238}$ in a fast reactor was studied by measuring the changes in reactivity when hot and cold samples were placed alternately at the center of Zeus. The results for $U^{235}$ are consistent with zero Doppler effect. For natural uranium a small negative temperature coefficient was observed, corresponding to increased capture in $U^{238}$ with increasing temperature, given by: $(d\sigma_c/dT) = 0.0006 \pm 0.0002$ mb/°C. The estimated Doppler temperature coefficient for the whole reactor Zeus was zero within experimental error. An upper limit could be placed on the magnitude of the Doppler coefficient (which might be positive or negative) of $10 \times 10^{-7}$ per °C, which is negligible compared with the magnitude of the total negative temperature coefficient of fast reactors (namely about $150 \times 10^{-7}$ per °C). (auth)

**17753** AERE-R/M-176
United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England.
AN ABSOLUTE MEASUREMENT OF THE EFFECTIVE DELAYED NEUTRON FRACTION IN THE FAST REACTOR ZEPHYR. D. B. McCulloch. July 1958. 10p.

The feasibility and technique of a method which may be used to measure the delayed neutron fraction in a reactor are investigated. The two experimental methods tried were satisfactory. The film method is economical in reactor time and less susceptible to changes in reactor power than is the scaler method; however, this method requires only standard equipment, and the counts are in a form ready for immediate calculation of results. (J.R.D.)

**17754** AERE-R/R-2562
United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England.
EXPERIMENTS ON SUB-CRITICAL ASSEMBLIES OF ENRICHED URANIUM PLATES IN NATURAL WATER. PART I. THE LAPLACIANS OF ⅛" PLATE ASSEMBLIES. S. E. Barden and A. K. McCracken. May 1958. 33p. $0.99(BIS).

A series of exponential and approach to critical experiments were conducted using laplacians of uranium—1.3 cobalt plates ⅛ in. thick in natural water. A description of the approach technique and method of analyzing results is presented. The theory on which this analysis is based is described. (J.R.D.)

**17755** AMF-GR-24-57
AMF Atomics, Inc., New York and American Machine and Foundry Co. Nuclear Lab., Greenwich, Conn.
MECHANICAL DISASSEMBLY OF SPENT POWER REACTOR FUELS FEASIBILITY REPORT. Final Report

[for] Period Covered: February 18 to September 18, 1957. W. W. Barton and J. J. Brooks. 193p. For Oak Ridge National Lab. Contract W-7405-eng-26, Subcontract 1085. (ER-7279). $34.80(ph OTS); $9.90(mf OTS).

The feasibility of mechanically disassembling spent power reactor fuels was examined. Included are studies of the disassembly area for a central reprocessing facility, conceptual designs of disassembly machines, disassembly sequences, and cost estimates for developing disassembly machines. Fuels from non-military heterogeneous power reactors are considered in relation to a facility whose capacity is 1 ton per day of natural uranium and 25 kg per day of highly enriched uranium. (J.R.D.)

**17756** ANL-5809
Argonne National Lab., Lemont, Ill.
MEASUREMENT OF THE DOPPLER TEMPERATURE EFFECT IN AN EBR-I TYPE ASSEMBLY. W. Y. Kato and D. K. Butler. July 1958. 32p. Contract W-31-109-eng-38. $1.00(OTS).

A measurement of the Doppler temperature effect has been made in the fast spectrum of a mock-up of the EBR-I reactor in ZPR-III. The effect was measured by thermally cycling samples of enriched uranium, natural uranium, and plutonium, and detecting the small changes in reactivity. The pile oscillation technique using a resonant detector was employed to measure the small oscillating component of the neutron flux. An upper limit $0.5 \times 10^{-8}$ $\Delta k/\Delta T$, was obtained for a 506-gram sample of $U^{238}$ in the spectrum of an EBR-I mock-up, and for a 235-gram sample of $Pu^{239}$ in a plutonium-fueled assembly of the same configuration. The results for natural uranium were inconclusive. (auth)

**17757** CF-55-4-53
Oak Ridge National Lab., Tenn.
DERIVATION OF THE THERMAL KINETIC EQUATIONS FOR THE PACKAGE REACTOR. J. C. Gallagher and M. L. Winton. Apr. 13, 1955. Decl. Sept. 26, 1958. 18p. Contract [W-7405-eng-26]. $3.30(ph OTS); $2.40 (mf OTS).

The time behavior of the APPR is reinvestigated. The purpose was to determine the transport lag of the coolant, accurate reactor thermal constants, and the primary circuit and steam generator characteristics. The derivation of the thermal kinetic equations of the reactor and associated power plant is presented. (W.D.M.)

**17758** CF-58-7-76
Oak Ridge National Lab., Tenn.
SURVEY OF THE STATIC NUCLEAR CHARACTERISTICS OF SMALL, ONE-REGION SLURRY REACTORS. B. E. Prince and M. W. Rosenthal. July 28, 1958. 40p. Contract [W-7405-eng-26]. $6.30(ph OTS); $3.00(mf OTS).

Survey calculations were made of the criticality characteristics of some small one-region thorium-oxide slurry reactors. Fuels considered were $U^{235}$ and $U^{233}$, and both $D_2O$ and $H_2O$ moderated systems were studied. Critical fuel concentrations were calculated as functions of size, temperature, and thorium concentration. For 4- to 5½-ft diameter spherical $ThO_2$-$D_2O$ reactors fueled with $U^{235}$, the minima in the $U^{235}$/Th ratio curves occurred at about 200 gm Th/liter. The critical ratio obtained for a 5-ft diameter bare $D_2O$ reactor at 280°C increased from 0.08 to 0.10 g $U^{235}$/g Th as the thorium concentration was increased from 200 to 400 gms per liter. (auth)

**17759** CF-58-7-99
Oak Ridge National Lab., Tenn.
DEPOSITION OF GAMMA-RAY HEATING IN STRATIFIED LEAD AND WATER SLABS. L. A. Bowman and D. K. Trubey. July 28, 1958. 27p. Contract [W-7405-eng-26]. $4.80(ph OTS); $2.70(mf OTS).

Typical results are given from a calculation of the deposition of heat in stratified lead and water slabs caused by a monodirectional, monoenergetic beam of gamma rays incident on the slabs. A total of 512 cases were calculated for infinite slabs with finite thicknesses of 1, 2, 4, and 6 mean free paths; source energies of 1, 3, 6, and 10 Mev, and source angles of incidence which were chosen to give slant slab thicknesses of 1, 2, 3, and 4 times the normal thickness. The results were fitted to an empirical formula, which can be simplified for special cases. While for the cases examined, the fit was usually good to within 5%, it is to be emphasized that the formula has been compared only with the results from a very limited number of parameters. (auth)

**17760** CF-58-8-1
Oak Ridge National Lab., Tenn.
FAST-NEUTRON FLUX MEASUREMENTS IN THE ORNL GRAPHITE REACTOR SHIELD. T. V. Blosser, G. W. Bond, L. A. Lee, D. T. Morgan, J. F. Nichols, R. C. Reid, A. B. Reynolds, T. O. P. Speidel, D. W. Vroom, and M. A. Welt. Aug. 14, 1958. 11p. Contract [W-7405-eng-26]. $1.80(ph OTS); $1.80(mf OTS).

In a study of the nuclear and physical properties of the concrete shield of the ORNL Graphite Reactor measurements were made of the fast-neutron fluxes in a hole through the shield. These fluxes were not included in the formal report of the study (ORNL-2195) since several uncertainties associated with the measurements made the absolute values unreliable. The attenuation curves at one energy may be reasonably accurate, however. (auth)

**17761** CF-58-9-41
Oak Ridge National Lab., Tenn.
CHEMICAL INDICATIONS OF HRT MISBEHAVIOR IN RUN 17-A. H. F. McDuffie. Sept. 18, 1958. 18p. Contract [W-7405-eng-26]. $3.30(ph OTS); $2.40(mf OTS).

The cause and significance of the changes in chemical composition of the HRT fuel and changes in reactivity during operation, particularly in run 17A, were investigated. It was concluded that a rise in reactor power level causes deposition of U, Cu, and Ni in some hydrolytic process within the core circulation system in a region which is at a position between zero and average nuclear importance. The deposition requires several minutes to several hours and is relatively easily reversible when the power is lowered. (J.R.D.)

**17762** FICO-106
Ford Instrument Co., Long Island City, N. Y.
CONTROL ROD DRIVE DEVELOPMENT FOR CLOSED CYCLE GAS COOLED REACTOR PROGRAM. Mar. 1958. 30p. Contract AT(30-3)-250. $4.80(ph OTS); $2.70(mf OTS).

The development and test program undertaken to produce an economical control rod drive mechanism suited to the requirements of a high temperature gas cooled reactor is described. The system design features are described as well as the behavior of the specially selected materials during the testing in a high temperature nonradioactive environment. (auth)

**17763** FICO-107
Ford Instrument Co., Long Island City, N. Y.
FISSION PRODUCT DIFFUSION INVESTIGATION FOR

CLOSED CYCLE GAS COOLED REACTOR PROGRAM. Mar. 1958. 57p. Contract AT(30-3)-250. $9.30(ph OTS); $3.60(mf OTS).

Cylindrical pellets of 24 grams of sintered 5.4% enriched $UO_2$ were clad in 5 and 10 mil thicknesses of stainless steel 316. These pellets were placed in aluminum containers and irradiated in the Brookhaven National Laboratory reactor in fluxes up to $10^{13}$ for periods up to 5 months. The irradiation cans were charged with helium and the helium atmosphere was periodically sampled and analyzed for fission product activity. By control of the heat transfer to the irradiation can, the temperature of the cladding surface has been maintained as high as 1700°F. To date there has been no evidence of diffusion of fission products through the stainless steel cladding or any evidence of loss of integrity of the cladding through mechanical failure. (auth)

**17764** FICO-108

Ford Instrument Co., Long Island City, N. Y.

KINETICS STUDY FOR CLOSED CYCLE GAS COOLED REACTOR PROGRAM. Mar. 1958. 64p. Contract AT(30-3)-250. $10.80(ph OTS); $3.90(mf OTS).

The transient behavior of the closed cycle, gas cooled reactor system for a 20,000 shaft horsepower merchant ship was investigated using a digital differential analyzer. In this cycle, the helium coolant is heated in the reactor and then passes through the high pressure turbine, a throttle valve, low pressure turbine provided with a bypass valve, the hot side of the recuperator, precooler, compressor, recuperator cold side, and back to the reactor inlet. Step function changes in reactor reactivity and heat release and independent perturbations of control elements at steady state full load conditions establish basic trends free from interaction effects. The basic requirement of constant reactor outlet temperature was postulated for reactor power control. This parameter was held fixed and the effects of ramp function closures of the throttle valve and openings of the bypass valve were evaluated. The system power level was changed by extracting and introducing gas at both the high and low pressure legs of the system. Finally, the study presents the results of two modes of system control for maneuvering operation. The demands of this condition were met by bypassing the low pressure turbine and positioning the throttle valve by (a) a regulatory signal from the high pressure turbine shaft speed and (b) programmed interlocks on bypass valve position. (auth)

**17765** FICO-109

Ford Instrument Co., Long Island City, N. Y.

CONTROL MATERIAL BURN-UP STUDY FOR CLOSED CYCLE GAS COOLED REACTOR PROGRAM. Mar. 1958. 21p. Contract AT(30-3)-250. $4.80(ph OTS); $2.70(mf OTS).

The spatial and time burnup characteristics of absorbing isotopes were studied for slab geometry with a constant impinging neutron current. For materials with single absorbing isotopes, generalized analytical expressions for the neutron current and isotope concentration were derived. An iterative numerical technique was developed to permit solution of the problem on a medium sized digital computer for europium with daughter isotopes. The results of these studies are expressed graphically in generalized coordinates to facilitate estimates of the required material thickness for the particular application. (auth)

**17766** GMR-104

General Motors Corp. Research Staff, Detroit.

BUCKLING ITERATION PROGRAM FOR THE IBM 704 COMPUTER. Burt E. Smith. Nov. 22, 1957. 26p.

An IBM 704 code which iterates between slab and cylinder geometries to converge on buckling (transverse diffusion of neutrons) values for each group in the first region of a nuclear reactor is described. This is used in conjunction with GNU II (Multigroup, One Dimension Diffusion Program, GMR 101). (auth)

**17767** HW-53672

General Electric Co. Hanford Atomic Products Operation, Richland, Wash.

OPTIMUM pH FOR PFTR COOLANT AND MODERATOR WITH ALUMINUM PROCESS TUBES. R. B. Richman and R. J. Lobsinger. Sept. 23, 1957. 5p. Contract [W-31-109-Eng-52]. $1.80(ph OTS); $1.80(mf OTS).

The most desirable operating conditions resulting in minimum corrosion of aluminum shroud tube and calandria surfaces without undue sacrifice of process tube life appear to be adjustment of coolant and moderator pH to approximately 6 and operation with coolant temperature not greater than 183°C. Coolant and moderator pH of 6 is desirable because the demineralizers contemplated for use with the PFTR provide water at this pH. (J.R.D.)

**17768** HW-54687

General Electric Co. Hanford Atomic Products Operation, Richland, Wash.

CORRELATION OF THEORETICAL AND EXPERIMENTAL VALUES OF THE RATIO OF FAST TO THERMAL FISSIONS. M. T. Lee. June 19, 1958. 27p. Contract W-31-109-Eng-52. $0.75(OTS).

A multigroup theory developed in connection with an investigation of inelastic scattering of fission neutrons was adapted for use in calculations of fast effect in solid fuel rods. Theoretical values of both $\epsilon$ and $\delta$ were calculated on this basis and compared with experimental values determined at Hanford and Argonne. (auth)

**17769** HW-55703

General Electric Co. Hanford Atomic Products Operation, Richland, Wash.

INTERIM REPORT FOR IMPROVED RUPTURE DETECTION SYSTEM DEVELOPMENT—R-84307. RESULTS OF DEVELOPMENT ACTIVITIES FROM DECEMBER 1956 TO DECEMBER 1957. A. G. Dunbar. Apr. 15, 1958. 46p. Contract [W-31-109-Eng-52]. $7.80(ph OTS); $3.30(mf OTS).

Present-day technical knowledge and stage of fuel element rupture detection development suggests an individual tube rupture detection system composed of an individual process tube sampling system which may in turn be plumbed to form vertical and horizontal crossheader systems, but preferably an individual tube monitoring system. Gamma spectrum monitoring techniques are currently applied to the horizontal crossheader system and to a prototype demonstration vertical header system, thus providing the sensitivity, detectability, and identification of individual fuel element rupture containing process tubes. On-pile testing of the prototype systems are being performed as a functional part of the CG-651, 112 tube, charge-discharge prototype installation. Individual sample lines have been extended to the far side C-Pile old Beta monitor room. At, and in, the C-Pile Beta monitor room, a vertical crossheader system and individual sample line monitoring system have been established. (auth)

**17770** IGR-TN/D-898

United Kingdom Atomic Energy Authority. Industrial Group. Dounreay Works, Caithness, Scotland.

TWO-GROUP DIFFUSION-THEORY CRITICALITY CALCULATIONS ON INTERACTING SLABS AND A BRIEF

REVIEW OF THE THEORY USED. R. I. McLeod. June 11, 1958. 25p.

The results of calculations done on the critical sizes of interacting slabs are reported. Two-group diffusion theory is used, and the limitations of this method are discussed. The slabs were assumed to contain a fissile solution of H/U = 300. The slabs were infinite in two dimensions, and the center-to-center distance for criticality was calculated in terms of the slab thickness. Two geometrical configurations were used: that of an infinite array, and that of two interacting slabs. The medium between the slabs, the reflector, was assumed to vary, and results are quoted for water, a boron solution with varying resonance escape probability, and for wood impregnated with boron. The results in the limiting case of infinite separation, i.e., a single slab, are also given, and comparison is made with the experimental data available. (auth)

**17771** NAA-SR-Memo-701(Rev.II)
North American Aviation, Inc., Downey, Calif.
SPECIFICATION FOR A WATER BOILER NEUTRON SOURCE CONSTRUCTED UNDER CONTRACT AT-11-1-GEN-8 AND INSTALLED AT CALIFORNIA RESEARCH AND DEVELOPMENT COMPANY, LIVERMORE, CALIFORNIA. Dec. 18, 1953. Changed from OFFICIAL USE ONLY Sept. 9, 1958. 13p. $3.30(ph OTS); $2.40 (mf OTS).

Specifications are given covering the design objectives and operational tests for a solution-type reactor for operation in the thermal power range 0 to 100 w. Operation at 100 w provides thermal fluxes of $4 \times 10^9$ in the central exposure tube and $2 \times 10^9$ at the core tank surface. The reactor core is a graphite-reflected, stainless steel sphere, 60 in. in diameter, containing enriched uranyl sulfate. (D.E.B.)

**17772** NDA-84-12
Nuclear Development Corp. of America, White Plains, N. Y.
SDR PROJECT QUARTERLY TECHNICAL PROGRESS REPORT NO. 5 FOR THE PERIOD MAY 1, 1958 THROUGH JULY 31, 1958. Sept. 30, 1958. 41p. Contract AT(30-3)-256. $9.30(ph OTS); $3.60(mf OTS).

Test results indicate that the design strength of 16,500 psi the safety factor based on the experimentally determined fatigue failure stress of 29,500 psi is 1.8. The basic specimen tested was a butt-weld type of T-joint. The barrier tube arrangement proposed for the SDR appears adequate for maintaining separation of simultaneous sodium and water leaks until corrective action can be taken. Preliminary design characteristics were developed for a two-region 200 Mwe reactor. Preliminary design of the control rod for the 10 Mwe reactor was completed, reactor control and instrumentation requirements were defined, and layout of the refueling machine was begun. A method for distributing $D_2O$ flow within the calandria was designed. (For preceding period see NDA-84-7.). (W.D.M.)

**17773** NP-6951
Westinghouse Electric Corp. Research Labs., East Pittsburgh, Penna.
WALL THICKNESS OF REACTOR THIMBLES. Research Report 8-0160-R1. G. Comenetz. Apr. 9, 1956. 40p.

A reactor is to contain pipes which are subject to high internal fluid pressure, and to high thermal stresses owing to irradiation that generates heat within the wall of a pipe. Formulas and graphs are given for the temperatures and stresses. Data are collected on the properties of the metals that may be used to make the pipes. There is a discussion of pipe strength in the light of several engineering codes. (auth)

**17774** TID-2507(Del.)
Technical Information Service, AEC.
NUCLEAR SCIENCE AND TECHNOLOGY. VOL. 1A, ISSUE 2, AUG. 1955. Decl. with deletions Feb. 26, 1957. 109p. $18.30(ph OTS); $6.00(mf OTS).

About eleven papers are included in this issue. Separate abstracts have been prepared for each paper. (W.L.H.)

**17775** TID-2507(Del.)(p.231-43)
[American Locomotive Co., New York.]
ARMY PACKAGE POWER REACTOR: AMERICAN LOCOMOTIVE CO. PROPOSAL. Kenneth Kasschau. p.231-43 [of] NUCLEAR SCIENCE AND TECHNOLOGY. VOL. 1A, ISSUE 2, AUG. 1955. 13p.

The American Locomotive Co. proposal for the Army Package Power Reactor is described. The reactor will be operated at the specified 10-megawatt power level and will have a net electrical output of 1825 kw. Conservative design has been employed throughout, and the end objective of remote installation has been borne in mind. The steam generator, which requires a 33° temperature difference to produce the superheated steam, is vertically mounted so that thermal convection will provide emergency cooling. An iron-water shield is provided which affords considerable weight saving if the aggregate for a concrete shield is lacking at a remote site. The main support member of the reactor vessel is the inner wall of the shield tank. This support, in combination with the vertical type steam generator, allows for very short pipe connections and leaves essentially no thermal expansion stresses in the pipe. A double-walled steel shell, 32 ft in diameter and 60 ft high with 2 ft of concrete between the linings, provides containment against nuclear accidents. When the reactor is refueled, spent elements may be removed under water to a deep water-filled storage pit outside the container. (auth)

**17776** TID-2507(Del.)(p.245-54)
[American Machine and Foundry Co. General Engineering Lab., Greenwich, Conn.]
ARMY PACKAGE POWER REACTOR: AMERICAN MACHINE AND FOUNDRY CO. PROPOSAL. Chris J. Brous and Franz S. Holzer. p.245-54 [of] NUCLEAR SCIENCE AND TECHNOLOGY. VOL. 1A, ISSUE 2, AUG. 1955. 10p.

The Army Package Power Reactor as conceived by the American Machine and Foundry Co. (AMF) is described. The general specifications of the reactor are outlined in Report ORNL-1613. Design features include new control rod drive mechanisms and a modified cooling system. (C.W.H.)

**17777** TID-2507(Del.)(p.255-61)
[Ford Instrument Co., Long Island City, New York.]
ARMY PACKAGE POWER REACTOR: FORD INSTRUMENT CO. PROPOSAL. Charles M. Rice. p.255-61 [of] NUCLEAR SCIENCE AND TECHNOLOGY. VOL. 1A, ISSUE 2, AUG. 1955. 7p.

Unique features of the proposed design include: driving control rods from beneath the reactor with the actuating system located exterior to the reactor compartment; use of concrete vessels for containment in the event of a rupture in the primary system; and use of hydraulically actuated control valves in the steam plant. A windowless noncombustible building would be provided. Maximum efficiency, minimum expense, simplicity, and safe operation were the primary design requirements for both the plant and the building. (auth)

**17778** TID-2507(Del.)(p.263-73)
[Foster Wheeler Corp., New York.]
ARMY PACKAGE POWER REACTOR: FOSTER WHEELER CORP. PROPOSAL. Theodore Stern. p.263-73 [of] NUCLEAR SCIENCE AND TECHNOLOGY. VOL. 1A, ISSUE 2, AUG. 1955. 11p.

The Army Reactors Branch of the AEC, in cooperation with the U. S. Army Corps of Engineers, will build a nuclear package power plant at Fort Belvoir, Va., which will be the prototype for a package plant suitable for a remote location. Fixed-price proposals were requested by the AEC for the design, construction, and test of this nuclear plant as based on the concept developed by Oak Ridge National Laboratory (ORNL) and presented in Report ORNL-1613. This article is a condensed version of the Foster Wheeler Corp. proposal. The considerations that the AEC applied in choosing a reactor concept and the criteria that were to be used in selecting the prime contractor guided Foster Wheeler in the design proposal. Standard equipment was chosen wherever possible, and necessary special equipment was specified on the basis that its design would entail a minimum amount of development work. In addition to supplying the buildings and equipment for the plant, the proposal included containment features that were necessitated by the densely populated area in which the prototype plant will be located. (auth)

**17779** TID-2507(Del.)(p.275-92)
[Kidde (Walter) Nuclear Labs., Inc., Garden City, N. Y.]
ARMY PACKAGE POWER REACTOR: KIDDE COMPANIES PROPOSAL. James J. Barker, John Faas, and William L. Webb. p.275-92 [of] NUCLEAR SCIENCE AND TECHNOLOGY. VOL. 1A, ISSUE 2, AUG. 1955. 17p.

The design proposed herein is similar to that described in Report ORNL-1613 with modifications to meet the Army Package Power Reactor requirements and to adapt the plant to the Fort Belvoir site. The primary flow is 6000 gal/min at 450°F and 1250 psia. A purge demineralizer and a boron-solution emergency scram are included. Saturated steam at 240 psia is generated using a simple regenerative cycle with three stages of feed-water heating. The net generation is 1800 kw for a 10 Mw reactor input with 85°F cooling water in the two-pass condenser. The largest heat loss is in the purge circuit. Ordinary concrete, supplemented by water and earth, is used for shielding. Concrete thicknesses range from 5 to 8 ft around the reactor compartment to 2 ft around the remainder of the primary circuit. The process auxiliaries consist mostly of water storage tanks, exchangers, pumps, and demineralizers. Total containment is provided for all radioactive emanations, gaseous or liquid. A partly buried spherical steel enclosure is provided to contain the maximum credible accident, which occurs as a result of a relatively slow accumulation of energy in the water of the primary circuit and leads to rupture of the system and flashing of the water to steam. (auth)

**17780** TID-2507(Del.)(p.293-303)
[Kuljian Corp., Philadelphia.]
ARMY PACKAGE POWER REACTOR: THE KULJIAN CORPORATION PROPOSAL. Herbert G. Johnson. p.293-303 [of] NUCLEAR SCIENCE AND TECHNOLOGY. VOL. 1A, ISSUE 2, AUG. 1955. 11p.

The Army Package Power Reactor as conceived by the Kuljian Corporation is described. General specifications of the reactor are outlined in Report ORNL-1613. Outstanding design features include a built-in heat exchanger boiler and new control rod mechanism. With a few modifications this reactor design may be converted to a boiling-water reactor type. (C.W.H.)

**17781** TID-2507(Del.)(p.305-9)
[Merritt-Chapman and Scott Corp., New York.]
ARMY PACKAGE POWER REACTOR: MERRITT-CHAPMAN AND SCOTT CORP. PROPOSAL. I. B. Purdy. p.305-9 [of] NUCLEAR SCIENCE AND TECHNOLOGY. VOL. 1A, ISSUE 2, AUG. 1955. 5p.

The Army Package Power Reactor as conceived by the Merritt-Chapman and Scott Corp. is described. General specifications of the reactor are outlined in Report ORNL-1613. (C.W.H.)

**17782** TID-2507(Del.)(p.311-19)
[Raymond Concrete Pile Co., New York.]
ARMY PACKAGE POWER REACTOR: RAYMOND CONCRETE PILE CO. PROPOSAL. John C. Schleck and Theodore Stern. p.311-19 [of] NUCLEAR SCIENCE AND TECHNOLOGY. VOL. 1A, ISSUE 2, AUG. 1955. 9p.

This proposal was predicated on utilizing to the fullest possible extent the ability of established companies to meet the requirements of nuclear power electric generation in accordance with accepted commercial practice. Gibbs and Hill, Inc., prepared basic sketches, heat balances, and flow diagrams for the complete plant and wrote specifications covering all major mechanical and electrical items of equipment. On the basis of these specifications firm prices were requested from several manufacturers for each item. For this purpose the primary system was considered as a unit. Plant orientation, layout, and construction represent an equitable compromise between considerations of first cost, operating efficiency, and the experimental nature of the project. Response by potential suppliers of the primary system was excellent and indicates that industry is prepared to furnish all components of a nuclear-powered electric generating plant on a competitive commercial basis. General specifications are outlined in ORNL-1613. (auth)

**17783** TID-2507(Del.)(p.321-7)
[Stearns-Roger Mfg. Co., Denver.]
ARMY PACKAGE POWER REACTOR: THE STEARNS-ROGER MFG. CO. PROPOSAL. R. W. Akerlow, F. Thurlow Lacy, and Mackey M. Payne. p.321-7 [of] NUCLEAR SCIENCE AND TECHNOLOGY. VOL. 1A, ISSUE 2, AUG. 1955. 7p.

The Army Package Power Reactor as conceived by the Stearns-Roger Mfg. Co. is described. General specifications of the reactor are outlined in Report ORNL-1613. (C.W.H.)

**17784** TID-2507(Del.)(p.329-33)
Bendix Aviation Corp. Research Labs., Detroit.
A HIGH-FLUX RESEARCH REACTOR FOR LARGE-VOLUME IRRADIATIONS. Richard G. Mallon and William R. Pearce. p.329-33 [of] NUCLEAR SCIENCE AND TECHNOLOGY. VOL. 1A, ISSUE 2, AUG. 1955. 5p.

The conceptual design of a fully enriched graphite-moderated research reactor intended for large-volume irradiations is presented. The reactor is cooled and fueled by a solution of $UO_2SO_4$ in light water which is circulated through the graphite in parallel tubes. For a reactor power of 120,000 kw, an average thermal flux of $4.4 \times 10^{14}$ nvt is obtained in the graphite. Fifteen through facilities are provided, one of which permits irradiation of specimens up to 16 by 16 in. in a thermal-neutron flux of $10^{15}$. (auth)

**17785** TID-2507(Del.)(p.335-42)
Iowa State Coll., Ames. Inst. for Atomic Research.
THE VAPOR-SLURRY REACTOR. R. L. Crowther.

p.335-42 [of] NUCLEAR SCIENCE AND TECHNOLOGY. VOL. 1A, ISSUE 2, AUG. 1955. 8p.

A circulating-fuel reactor that utilizes a suspension of solid particles of fissionable material in a vapor as the coolant is described. The reactor core serves as the superheater in the vapor cycle. Several cycles that would be suitable for a vapor-slurry reactor design are discussed. An analysis of a proposed reactor with a water vapor-uranium dioxide fuel and a heterogeneous core is presented. Two other vapor-slurry reactor designs are described. (auth)

**17786** TID-7020(Vol. II)
Westinghouse Electric Corp. Bettis Plant, Pittsburgh. SHIPPINGPORT ATOMIC POWER STATION MANUAL. VOLUME II. [1958].

Revisions may be issued for the various systems listed below. System Description:
No. 1. REACTOR COOLANT SYSTEM. 45p. $7.80 (ph OTS); $3.30(mf OTS). No. 2. PRESSURIZER AND PRESSURE RELIEF SYSTEM. 68p. $10.80(ph OTS); $3.90(mf OTS). No. 3. COOLANT CHARGING SYSTEM. 61p. $10.80(ph OTS); $3.90(mf OTS). No. 4. COOLANT DISCHARGE AND VENT SYSTEM. 85p. $13.80(ph OTS); $4.80(mf OTS). No. 5. PWR COOLANT PURIFICATION SYSTEM. 40p. $7.80(ph OTS); $3.30 (mf OTS). No. 6. REACTOR COOLANT SAMPLING SYSTEM. 38p. $7.80(ph OTS); $3.30(mf OTS). No. 7. COOLANT CHEMICAL ADDITION SYSTEM. 35p. (AECU-3646). $6.30(ph OTS); $3.00(mf OTS). No. 8. DECAY HEAT REMOVAL SYSTEM. 42p. (Earlier issue assigned AECU-3591). $7.80(ph OTS); $3.30 (mf OTS). No. 9. REACTOR PLANT COMPONENT COOLING WATER SYSTEM. 62p. $10.80(ph OTS); $3.90(mf OTS). No. 10. VALVE OPERATING SYSTEM. 67p. (AECU-3576). $12.30(ph OTS); $4.50 (mf OTS). No. 11. FAILED ELEMENT DETECTION AND LOCATION SYSTEM. 52p. $9.30(ph OTS); $3.60 (mf OTS). No. 12. REACTOR ROD CONTROL SYSTEM. 59p. $12.30(ph OTS); $4.50(mf OTS). No. 13. REACTOR POWER AND TEMPERATURE CONTROL SYSTEM. 17p. $3.30(ph OTS); $2.40(mf OTS). No. 14. REACTOR PROTECTION SYSTEM. 76p. $12.30(ph OTS); $4.50(mf OTS). No. 15. NUCLEAR INSTRUMENTATION SYSTEM. 14p. (AECU-3586). $3.30(ph OTS); $2.40(mf OTS). No. 16. PRIMARY PLANT CONTROL SYSTEM. 34p. $6.30(ph OTS); $3.00(mf OTS). No. 17. PRIMARY PLANT INSTRUMENTATION SYSTEM. 60p. $12.30(ph OTS); $4.50(mf OTS). No. 18. OPERATIONAL RADIATION MONITORING SYSTEM. 14p. $3.30(ph OTS); $2.40(mf OTS). No. 19. REACTOR PLANT CONTAINER AIR COOLING SYSTEM. 57p. $10.80(ph OTS); $3.90(mf OTS). No. 20. REMOTE VIEWING SYSTEM. 11p. $3.30(ph OTS); $2.40(mf OTS). No. 21. SAFETY INJECTION SYSTEM. 60p. $10.80(ph OTS); $3.90(mf OTS). No. 22. CANAL WATER SYSTEM. 66p. $10.80(ph OTS); $3.90(mf OTS). No. 23. CORE REMOVAL COOLING SYSTEM. 27p. $4.80(ph OTS); $2.70(mf OTS). No. 24. RADIOACTIVE WASTE DISPOSAL SYSTEM. 314p. (Earlier issue assigned AECU-3606). $55.80(ph OTS); $11.10 (mf OTS). No. 25. PWR SAFETY RADIATION MONITORING SYSTEM. 25p. $4.80(ph OTS); $2.70(mf OTS). No. 26. CORE INSTRUMENTATION SYSTEM. 14p. $3.30(ph OTS); $2.40(mf OTS). No. 27. MAIN STEAM SYSTEM. 13p. $3.30(ph OTS); $2.40(mf OTS). No. 28. BOILER FEEDWATER SYSTEM. 20p. $3.30 (ph OTS); $2.40(mf OTS). No. 29. CONDENSATE SYSTEM. 22p. $4.80(ph OTS); $2.70(mf OTS). No. 31. DC CONTROL SYSTEM. 28p. $4.80(ph OTS); $2.70 (mf OTS). No. 32. REACTOR PLANT CONTAINER GRAVITY DRAINAGE SYSTEM. 37p. $6.30(ph OTS); $3.00(mf OTS). No. 33. NEUTRON SHIELD TANK. 14p. $3.30(ph OTS); $2.40(mf OTS). No. 34. CONTROLLED STEAM RELIEF SYSTEM. 16p. (WAPD-PWR-PCR-44). $3.30(ph OTS); $2.40(mf OTS). No. 36. MISCELLANEOUS SERVICE LINES. 36p. (AECU-3592). $7.80(ph OTS); $3.30(mf OTS). App. A. SHIELD DESIGN DESCRIPTION. 34p. $6.30(ph OTS); $3.00(mf OTS). App. B. REACTOR PLANT SITE DESCRIPTION. 49p. $7.80(ph OTS); $3.30(mf OTS). App. C. COMPONENT REMOVAL AND REPLACEMENT GUIDE. 17p. $3.30(ph OTS); $2.40(mf OTS). App. D. DECONTAMINATION GUIDE. 61p. $10.80(ph OTS); $3.90(mf OTS).

**17787** WAPD-SC-540(Vol.I(Del.))
Westinghouse Electric Corp. Bettis Plant, Pittsburgh. INTERIM REPORT ON REACTOR HAZARDS ASSOCIATED WITH THE PRESSURIZED WATER REACTOR PLANT AT SHIPPINGPORT, PENNSYLVANIA. Dec. 1955. Decl. with deletions May 26, 1958. 163p. Contract AT-11-1-GEN-14. $25.80(ph OTS); $7.80(mf OTS).

An evaluation of the external radiation hazards associated with the PWR plant is presented. In an analysis of reactor accidents it is pointed out that the only situation involving release of significant quantities of radioactivity to the plant container is a primary loop break. These breaks are considered from the standpoint of small, medium, and major defects and include examinations of hazards to surrounding areas due to radioactivity from the primary coolant, and those arising from release of the core-contained fission products through container breach. (J.R.D.)

**17788** WAPD-SC-540(Vol.II(Del.))
Westinghouse Electric Corp. Bettis Plant, Pittsburgh. INTERIM REPORT ON REACTOR HAZARDS ASSOCIATED WITH THE PRESSURIZED WATER REACTOR PLANT AT SHIPPINGPORT, PENNSYLVANIA. Dec. 1955. Decl. with deletions May 26, 1958. 127p. Contract AT-11-1-GEN-14. $19.80(ph OTS); $6.30(mf OTS).

An analysis of zirconium-water reactions under conditions of accidental coolant loss is presented, including the production of hydrogen and a study of its explosive limits in the probable situation consequent to a major break in the PWR primary system. Situations of partially and fully uncovered reactor cores are examined, along with considerations of various possible undesirable water conditions resulting from improper reactor operation. The power complex into which the PWR is to be integrated is discussed, including power demands, methods of control, and reliability. The applicable codes and regulations are discussed pointing out that questions concerning the non-conventional portions of the PWR plant were resolved. Meteorological data are discussed, and several charts are included. Primary loop materials are examined pointing out that ASME specifications are referred to except for piping which must conform to ASTM specifications and undergo ultrasonic tests. Materials of construction of the primary plant are examined, and it is concluded that all conditions leading to ferrous metal and alloy deficiencies are largely absent. An analytical expression for external gamma dosage around the reactor site from a sudden emission of radioactivity was calculated, along with calculation of the dosage in less severe situations of core meltdown with a breached container. Finally, some situations in which the primary coolant is discharged to the atmosphere are considered. (J.R.D.)

**17789** YAEC-95

Westinghouse Electric Corp. Atomic Power Dept., Pittsburgh.

MONTHLY PROGRESS REPORT FOR THE PERIOD AUGUST 1 TO 31, 1958. R. W. Garbe and H. E. Walchli. Sept. 20, 1958. 16p. For Yankee Atomic Electric Co. Contract AT(30-3)-222, Subcontract No. 1. $3.30(ph OTS); $2.40(mf OTS).

Specific projects comprising the Yankee Power Reactor development effort are briefly reviewed. (For preceding period see YAEC-92.) (D.E.B.)

**17790**

POSSIBILITIES OF CLOSED-CYCLE GAS TURBINES IN ATOMIC ENERGY PLANTS. Curt Keller. Atomkern-Energie 3, 304-12(1958) Aug.-Sept. (In German)

Studies and projects for gas-cooled high-temperature reactors have been considerably intensified following the successful operation of the first atomic power plants in England and France. With the increasing development of fuel elements, suitable possibilities present themselves for using gas-cooled reactors as heat source for gas turbines, especially of the closed-cycle type. This type of machinery is working already in different installations with fossil fuels. The operating experience gathered will be most useful for their application in future atomic energy plants. Advantages and disadvantages of different layouts and cycles are dealt with. On the basis of some examples the effect of employing various gases for the reactors and working medium is discussed. The design of turbines and apparatuses using different gases is shown. (auth)

**17791**

COOLANT TRAP IN CONNECTION WITH A CLOSED-CYCLE GAS TURBINE FOR THE REMOVAL OF GASEOUS FISSION PRODUCTS FROM THE COOLANT (HELIUM) OF A NUCLEAR REACTOR. K. Hintermann (Brown Boveri (Baden) and Reactor AG, Zurich) and W. Winkler (Escher Wyss and Reactor AG, Zurich). Atomkern-Energie 3, 313-15(1958) Aug.-Sept. (In German)

A cold trap is proposed for cooling activated carbon used to remove gaseous fission products from the cooling system of a gas-cooled reactor. On the assumption that all the xenon formed diffuses in the heat transfer gas, an estimation was made of whether the equilibrium concentration of $Xe^{135}$ could be reduced without the use of activated carbon. (J.S.R.)

**17792**

ADVANCES IN THE DEVELOPMENT OF ORGANIC MODERATED NUCLEAR POWER REACTORS OF GREAT POWER. H. Polak (Atomics International Division, North American Aviation, Inc., Canoga Park, Calif.). Atomkern-Energie 3, 315-20(1958) Aug.-Sept. (In German)

The paper is intended as a sequel to the presentation "Organic Moderated and Cooled Reactors" before the Reaktortagung, June 1957, which was published in Atomkernenergie 2, p. 390-396(1957). The main results of nine months of operation of the OMRE (Organic Moderated Reactor Experiment) are mentioned, and it is observed that these coincide well with the anticipated behavior as predicted on the basis of earlier loop experiments. The heat transfer properties at higher concentrations of radiation damage products (polymers) appeared to undergo surprisingly little change in contrast with the expected gradual worsening of heat transfer. This will tend to increase the obtainable power output of given designs and probably allow operation at higher polymer contents than originally foreseen, thereby reducing the make-up requirements. The physical characteristics of the OMRE such as critical loading, temperature coefficient, and general stability appeared to be close to the predicted values. Radiation levels in the primary circuit area during full power operation appear to be so low that maintenance is possible during operation. The reactor has been run for a full month at 30% polymer concentration and is, at the time of this writing, brought to a still higher steady state percentage of breakdown products in the coolant stream. No evidence whatsoever of fouling or precipitation has been observed. The reactor behaves in a routine manner in all respects and invites immediate application of the OMR principle to reactors for large scale central stations. Final design on one 11.4 Mwe unit for the city of Piqua, Ohio, has now started. A short description is given of OMR power reactors. The use of magnetic jack mechanisms for control and safety rods provides a reactors top shield without penetrations, as well as an unpenetrated lower core vessel, still avoiding any interference from the control rods during fuel changing. The new finned-plate fuel element is mentioned as well as the use of a liquid pressurizing pump instead of nitrogen gas pressurization. It is conservatively predicted that the cost of organic liquid make-up for these designs will not contribute more than one half to one mill per kwh to the total power cost. In case operation at higher polymer concentrations appears practicable, this figure may even be lower. More detailed pricing information available now, has shown that the original cost estimate of around $220 per kw installed for a 150 Mwe plant can actually be realized without difficulty. In concluding it is remarked that in the Organic Moderated Reactor concept there now remain no basic problems to be solved any longer and a direct extrapolation to full size power plants is completely justified. (auth)

**17793**

SODIUM COOLING OF NUCLEAR REACTORS. Werner Mialki (Univ. of Berlin). Atomkern-Energie 3, 321-8 (1958) Aug.-Sept. (In German)

In spite of difficulties in its handling, liquid sodium could play an important role in the future as a reactor coolant. At the present state of technological development, sodium can be considered only for fast reactors, since it does not slow down neutrons. Sodium is also of interest for thermal reactors since it allows a high temperature to be reached without pressure. The technology of sodium and its corrosive effects are described. Heat transfer by sodium and the possibility of calculating heat transfer with Nusselt's potential formulas are discussed. The radioactivity induced in the sodium by neutron beams is important in its utilization, and the radioactivity equilibrium can be calculated. The construction of heat exchangers, pumps, and instruments for pressure, level, and flow measurements are described. Some data on the operation of the Sodium Reactor Experiment are given. (auth)

**17794**

CALCULATION OF THE OPTIMUM COOLANT STATE IN GAS COOLED REACTORS. H. Benzler (Babcock und Wilcox, Oberhausen, Germany). Atomkern-Energie 3, 331-6(1958) Aug.-Sept. (In German)

Net power and thermal efficiency of a reactor plant can be calculated by two simple equations as functions of coolant pressure drop and reactor inlet and outlet temperatures. There exists a characteristic curve in

the power-efficiency diagram, all points of which define the most favorable coolant design values. The construction of the curve is described. (auth)

**17795**

THE TRANSIENT BEHAVIOR OF THE HEAT TRANSFER FROM FUEL ELEMENTS TO A COOLANT OF CONSTANT (BOILING) TEMPERATURE IN A ONE DIMENSIONAL HEAT FLUX. A. Kirchenmayer (Technische Hochschule, Stuttgart). Atomkern-Energie 3, 337-41(1958) Aug.–Sept. (In German)

With certain assumptions, the transfer function of the fuel element (ratio of the Laplace-transform of the relative change of the heat flux crossing the surface of the fuel elements to the Laplace-transform of the relative change of the power) is derived applying the Fourier differential equation of heat conduction. This transfer function can be approximated in a sufficiently large range by the function $Y(p) = 1/(1 + \Theta p)$. The width of this range and the magnitude of the constant $\Theta$ depends upon the geometry, the local film heat-transfer coefficient, and the thermal conductivity. (auth)

**17796**

THE QUESTION OF THE TEMPERATURE DISTRIBUTION IN A BARE CYLINDRICAL FUEL ELEMENT OF GREAT LENGTH IN THE NONSTEADY STATE (HEATING UP). Willy Kattwinkel (L. & C. Steinmüller, Gummersbach, Germany). Atomkern-Energie 3, 342-5(1958) Aug.–Sept. (In German)

The partial differential equation of heat conduction for a long cylindrical fuel element without canning is solved in the nonsteady state (heating up). Use is made of the Laplace transformation. The inversion integral as a main problem in application of integral transformations is thoroughly treated. In a typical case after 1 second the temperature of the outer surface exceeds that in the axis; but these conditions have reversed 1 second later. After 50 seconds temperature distribution almost attains its steady state distribution, difference being less than 4 per cent. Maximum temperature difference within the fuel element occurs after attaining steady-state distribution. (auth)

**17797**

THE BR-2 REACTOR. Bull. Inform. Assoc. beige develop. pacifique energie atomique No. 8, 9-10(1957) May. (In French)

The initial design of the BR-2 research reactor is given. It will use enriched uranium alloyed with aluminum as fuel, beryllium as moderator, and ordinary water as coolant. (J.S.R.)

**17798**

NEW MATERIALS FOR REATORS. D. Tytgat. Bull. Inform. Assoc. belge develop. pacifique energie atomique No. 12, 15-20(1958) Jan. (In French)

A summary is presented on the characteristics of fuels, claddings, and moderators used in thermal reactors. (J.S.R.)

**17799**

HIGH FLUX REACTOR FOR MATERIAL TESTING, THE BR-2. M. J. Planquart and M. F. Van Geertruyden. Bull. Inform. Assoc. belge develop. pacifique energie atomique No. 14, 3-6, 8-13(1958) May. (In French)

The design of the BR-2, a high flux research reactor, is described. It is a heterogeneous reactor with highly enriched uranium and cooled and moderated by light water under pressure. The nuclear and hydrodynamic characteristics are given. (J.S.R.)

**17800**

AUTOMATIC CONTROL OF NUCLEAR REACTORS. T. Tanasescu. Electrotehnica 4, No. 8, 342-8(1956). (Translated from Referat. Zhur. Fiz. No. 5, 1957, Abstract. No. 11318.)

**17801**

ECONOMIC COMPARISON OF ZIRCALOY AND STAINLESS STEEL IN POWER REACTORS. M. Benedict (Massachusetts Inst. of Tech., Cambridge). Energia nucleare (Milan) 5, 493-508(1958) Aug. (In Italian)

The principal results of a study on the comparative economy of using Zircaloy or stainless steel in five representative power-producing thermal reactors are presented. (J.S.R.)

**17802**

FABRICATION TECHNOLOGY OF CERAMIC FUEL ELEMENTS. C. Corsetti (CISE, Milan). Energia Nucleare (Milan) 5, 509-21(1958) Aug. (In Italian)

The techniques of fabrication of bulk $UO_2$ are discussed in relation to their importance in ceramic fuel element production. The various methods of producing the pellets by the conventional processes of powder metallurgy, such as cold pressing, isostatic pressing, hot pressing, extrusion, and slip casting, are described. Particular attention was given the cold pressing technique, as it is the only one used for industrial purposes. (tr-auth)

**17803**

ATOMIC ROCKET NEAR TEST FIRING. ROVER EXPECTED TO BACK PROPONENTS OF NUCLEAR POWER. Missiles and Rockets 4, No. 13, 30(1958) Sept. 29.

The test facilities at Jackass Flats, Nevada, are described. Details of the rocket are given and its potentials discussed. The radiation and temperature problems are discussed. (W.D.M.)

**17804**

REACTOR TEST LOOPS. 4. OBTAINING THE RESULTS. D. T. Norsworthy (Atomic Energy Research Establishment, Harwell, Berks., Eng.). Nuclear Power 3, 431-4(1958) Sept.

The various types of information required from reactor test loops are discussed. The ways in which results are obtained from different types of loops are considered in detail. (W.D.M.)

**17805**

HEAT EXTRACTION IN POWER REACTORS. 4. G. Boxer (Birmingham Coll. of Tech., Eng.). Nuclear Power 3, 439-43(1958) Sept.

The estimation of pressure drops in the primary coolant due to the effects of fluid friction and change of density due to addition of heat is dealt with. The criteria governing the choice of a suitable primary coolant are discussed. (W.D.M.)

**17806**

GENEVA REVIEWS REACTOR PROGRESS. Nucleonics 16, No. 9, 25-8(1958) Sept.

A summary is presented of the papers given at Geneva on power reactor design and experience, with special emphasis on the Russian reactor program. (J.S.R.)

**17807**

REACTOR PROJECTS. Nucleonics 16, No. 9, 72-7, 130, 132, 134, 136, 138-43(1958) Sept.

A survey is given of the papers presented at the Geneva Conference on reactor development and operation. (J.S.R.)

**17808**

NEW REACTOR CONCEPTS. Nucleonics 16, No. 9, 78-82(1958) Sept.

The new reactor concepts presented at Geneva include the British advanced gas cooled reactor and the advanced breeder reactor, the Canadian organic-cooled heavy water reactor, a consideration of steam cycles for advanced gas cooled reactors, and the American pulsed research reactor and the advanced sodium cooled reactor. (J.S.R.)

**17809**

SHIP PROPULSION. Nucleonics 16, No. 9, 92-3(1958) Sept.

Reports were presented at Geneva on the nuclear ships Lenin and Savannah. Britain, France, and Japan presented economic studies and original designs for nuclear-powered merchant ships. (J.S.R.)

**17810**

REACTOR PHYSICS. Nucleonics 16, No. 9, 94-7(1958) Sept.

Papers presented at Geneva on reactor physics discussed burnable poisons, Pu fast reactor performance, and the EBR-I Mark-III. (J.S.R.)

**17811**

NUCLEAR FUELS. Nucleonics 16, No. 9, 98-103(1958) Sept.

A summary is given of radiation effects on fuel elements and fabrication of fuels to provide reliable economic operation as reported by the United States, France, Germany, and the United Kingdom at Geneva. (J.S.R.)

**17812**

FUEL CYCLES. Nucleonics 16, No. 9, 104-6(1958) Sept.

A number of studies were presented at the Geneva Conference on fuel cycling. These included reports on pressurized water reactors, light water recycling, $H_2O$-Th experiments, Calder Hall recycle, Th - $U^{233}$ economics, and Pu liquid metal fuel reactor. (J.S.R.)

**17813**

MATERIALS. Nucleonics 16, No. 9, 108-10, 112-16, 118, 120, 122, 124(1958) Sept.

Data presented at the Geneva Conference on nuclear materials such as heavy water, zirconium, graphite, sodium, and polyphenyls are summarized. (J.S.R.)

**17814**

HOW TO SOLVE THE REACTOR EQUATION IN ELEVEN COORDINATE SYSTEMS. N. G. Sjöstrand (AB Atomenergi, Stockholm). Nukleonik 1, 89-93(1958) Aug.

The differential equation for the neutron flux in a bare reactor is $\nabla^2\Phi + B^2\Phi = 0$ according to the one-group theory. The eleven coördinate systems in which it is possible to solve this equation by separation of the variables are listed. For each system the coördinate surfaces, the form of the reactor equation, and the resulting ordinary differential equations are given. The fundamental solutions to these equations are included when they can be expressed in standard functions, and also the geometric buckling for some cases. (auth)

**17815**

THE $\epsilon$ FACTOR IN QUASI-HOMOGENEOUS REACTORS. W. Oldekp (Siemens-Schuckertwerke AG, Erlangen, Germany). Nukleonik 1, 94-100(1958) Aug. (In German)

A method for the calculation of the $\epsilon$ factor in quasi-homogeneous reactors was developed which considers the epithermal fission occurring below the $U^{238}$ fission threshold. Numerical calculations show that in uranium–$H_2O$ systems with high uranium content, epithermal $U^{235}$ fission leads to a considerable increase of the $\epsilon$ factor. The method is applicable in principle to the heterogeneous reactor. (tr-auth)

**17816**

A REACTIVITY PROGRAM WITH A PRE-DETERMINED CHANGE OF REACTOR POWER. H. Grümm (Inst. für Theoretische und Angewandte Physik, Technischen Hochschule, Stuttgart). Nukleonik 1, 101-3(1958) Aug. (In German)

The basic problem of reactor kinetics allows an inversion: a specific transient course of the reactor power is given and the appropriate transient course of the reactivity (reactivity program) is sought. The increase of the reactor to a new power level was investigated, whereby a more linear course better adjusted to real circumstances was given which leads to closed expressions for the reactivity. (tr-auth)

**17817**

LINES OF REACTOR DEVELOPMENT. III. M. Bogaardt. R C N Bull. 2, 81-3(1958) July. (In Dutch)

The present state of developement of the various reactor types of interest today is described. Possible areas of cost reduction in the production of nuclear energy are discussed. (J.S.R.)

**17818**

THE EFFECT OF THE REFLECTOR IN HETEROGENEOUS REACTORS. Fernando E. Prieto C. (Univ. Nacional de Mexico and Instituto Nacional de la Investigacion Cientifica, Mexico). Rev. mex. fis. 7, 55-64 (1958). (In Spanish)

A one group theory of neutrons is used in conjunction with the homogeneous theory of heterogeneous reactors developed by Medina to obtain the equations for a cylindrical heterogeneous reactor of finite size surrounded by a reflector. A method is given to solve the equations without assuming the thickness of reflector, which is also calculated. The method is applied to some known reactors, and the results are in good agreement with the experimental data. (auth)

## Nuclear Transformation

**17819**

($\gamma$,n) AND ($\gamma$,2n) REACTIONS IN $^{93}$Nb. E. Silva, J. Goldemberg, and P. B. Smith (Univ. of Sao Paulo, Brasil), and L. Marquez (Centro Brasileiro de Pesquisas Fisicas, Rio de Janeiro). Nuovo cimento (10) 9, 17-22(1958) July 1.

The ($\gamma$,n) cross section of $Nb^{93}$ was measured by the residual activity method. By combining this result with the total neutron yield curve, it was possible to separate the contributions of the ($\gamma$,n) and ($\gamma$,2n) reactions. The ratio of these cross sections was then compared with special attention to the 2.35 isomeric state ($T_{1/2}$ = 13 hr) reported by James; this activity was not found, and an upper limit of 0.02% of the 0.93 Mev line was determined. An activity of 3.2% abundance due probably to $\gamma$ rays of annihilation of positrons was found. (auth)

**17820**

PHOTOPROTONS FROM NITROGEN. G. Cortini, C. Milone, and R. Rinzivillo (Univ. of Catania, Italy and Centro Siciliano di Fisica Nucleare, Cantania, Italy) and C. Tribuno (Univ. of Turin and Istituto Nazionale di Fisica Nucleare, Turin). Nuovo cimento (10) 9, 188-91 (1958) July 1.

The spectrum of photoprotons from nitrogen irradiated with bremsstrahlung of 18, 23, and 30 Mev energy was studied using photographic emulsions. (L.T.W.)

**17821**

SPECTRUM OF PROTONS FROM n, p REACTIONS AT 13.4 AND 17.5 Mev. L. Colli (CISE Labs., Milan), M. Pignanelli (Univ. of Milan and Istituto Nazionale di Fisica Nucleare, Milan), and A. Rytz and Z. Zurmühle (Univ. of Zurich). Nuovo cimento (10) 9, 280-8(1958) July 16.

Measurements are presented on the energy distribution of protons emitted in (n, p) reactions on Al and Ni in the natural isotopic mixture. These measurements have been taken with neutrons of energy of 17.5 and 13.4 Mev to study how the proton energy distribution varies with the incoming neutron energy in order to establish which process is responsible for the (n, p) reaction. The results give evidence for the fact that the statistical evaporation theory is unsuitable for explaining the proton spectra obtained and that the spectrum shape does not depend on the residual nucleus excitation energy but seems determined by the energy of emitted protons. (auth)

**17822**

ANGULAR DISTRIBUTION OF PHOTOPROTONS FROM SILICON. V. Emma, C. Milone, and A. Rubbino (Univ. of Catania, Italy and Centro Siciliano di Fisica Nucleare, Catania, Italy). Nuovo cimento (10) 9, 343-5 (1958) July 16.

The photoprotons from natural silicon irradiated with a collimated 30-Mev bremsstrahlung beam were studied. It is concluded that in the Si photoproton spectrum there is a rather strong anisotropic component due to its direct emission in the energy range $E_p > 5$ Mev, while the isotropy of the $E < 3.5$ Mev component indicates that probably a major part of it is emitted after the formation of a compound nucleus. (L.T.W.)

**17823**

PHENOMENOLOGICAL RELATION BETWEEN ELECTRON AND PHOTON DISINTEGRATION OF NUCLEI. B. Bosco and S. Fubini (CERN, Geneva). Nuovo cimento (10) 9, 350-2(1958) July 16.

A theoretical relation (in electric dipole approximation) between all electron and photon differential cross sections is derived. (L.T.W.)

**17824**

THE NON-MESONIC DECAY IN FLIGHT OF A He HYPERFRAGMENT. M. Baldo Ceolin, W. F. Fry, and H. Huzita (Univ. of Padua and Istituto Nazionale di Fisica Nucleare, Padua). Nuovo cimento (10) 9 551-3(1958) Aug. 1.

During a systematic scanning of G-5 emulsions, exposed to a 4.5-Bev pion beam from the Berkeley bevatron, an event was found which is interpreted as a non-mesonic decay in flight of a He hyperfragment. Velocity and charge estimates are obtained. (W.D.M.)

**17825**

SPONTANEOUS FISSION FRAGMENT VELOCITY MEASUREMENTS AND COINCIDENT GAMMA SPECTRA FOR $Cf^{252}$. J. C. D. Milton and J. S. Fraser (Atomic Energy of Canada Ltd., Chalk River, Ont.). Phys. Rev. 111, 877-85(1958) Aug. 1.

The velocities of both fission fragments from the spontaneous fission of $Cf^{252}$ were measured simultaneously with the pulse-height spectrum produced by the fission gamma rays in a large NaI(Tl) crystal. The average total kinetic energy before neutron emission is found to be 181.9 Mev with a full width at half-maximum of 17.5 Mev at the most probable mass ratio 1.33. The width was corrected for neutron recoil and the average total kinetic energy for the effect of the angular dispersion of the fragments by neutrons. The yield of gamma rays shows a pronounced dip in the region where one of the fragments is near the doubly magic nucleus $Sn^{132}$. There is a suggestion that the average gamma-ray energy is higher in this region. The correlation in number of gamma rays with total kinetic energy is very small and can be represented by $1/(N_\gamma)\ (dN_\gamma/dE_T) = -0.0029^{+0.0007}_{-0.0011}$ Mev$^{-1}$. (auth)

**17826**

FURTHER RADIOCHEMICAL STUDIES OF THE HIGH-ENERGY FISSION PRODUCTS. P. C. Stevenson, H. G. Hicks, W. E. Nervik, and D. R. Nethaway (Univ. of California, Livermore). Phys. Rev. 111, 886-91(1958) Aug. 1.

Formation cross sections of various $U^{238}$ fission products were measured as a function of bombarding-particle energy, using protons (10 to 340 Mev) and deuterons (20 to 190 Mev). The reactions $Al^{27}(p,3pn)Na^{24}$ and $Al^{27}(d,\alpha p)Na^{24}$ were used as monitoring reactions to measure effective cyclotron beam intensity. Fission-product distribution curves and total fission cross sections were measured. Above 50-Mev bombarding energy, the fission-product distribution is not symmetrical about a given mass number at a given bombardment energy. (auth)

**17827**

$T(t,\alpha)n,n$ REACTION. Nelson Jarmie and Robert C. Allen (Los Alamos Scientific Lab., N. Mex.). Phys. Rev. 111, 1121-8(1958) Aug. 15.

The alpha particle spectra from the $T(t,\alpha)n,n$ reaction were measured at a laboratory angle of 30° for triton energies ranging from 0.95 to 2.10 Mev and at laboratory angles of 30, 60, 90, and 120° for 1.9-Mev incident tritons. Absolute cross sections are obtained. Analysis of the spectra in terms of a two-stage process involving the formation and breakup of $He^5$ is discussed. Evidence for neutron-neutron correlation is observed but no evidence is found for a bound dineutron. (auth)

**17828**

TRITON REACTION CROSS SECTIONS. Robert C. Allen and Nelson Jarmie (Los Alamos Scientific Lab., N. Mex.). Phys. Rev. 111, 1129-30(1958) Aug. 15.

Measurements of the $D(t,\alpha)n$ reaction cross section at triton energies of 1.9 and 1.5 Mev were made to resolve a disagreement among previously published values. Corrections for published values of the $He^4(t,t)He^4$ and $T(t,t)T$ scattering cross sections are also suggested. (auth)

**17829**

PROTON-GAMMA RAY ANGULAR CORRELATIONS IN THE $Si^{28}(d,p\gamma)Si^{29}$ REACTION. H. A. Hill and J. M. Blair (Univ. of Minnesota, Minneapolis). Phys. Rev. 111, 1142-7(1958) Aug. 15.

The $Si^{28}(d,p\gamma)Si^{29}$ reaction was studied by measuring angular distributions of the protons leaving $Si^{29}$ in its first and second excited states and by measuring the correlation between the protons of each group and the gamma rays emitted from the corresponding level. The angular distributions of proton groups $p_1$ and $p_2$ exhibit large peaks in the backward direction, indicating that heavy-particle stripping may be important. The $(p_1,\gamma)$ correlations were found to be isotropic to ±6%. This is substantially different from the correlation which was observed at a higher deuteron energy. The $(p_2,\gamma)$ cor-

relations are consistent with a $5/2+$ level in $Si^{29}$ at 2.03 Mev. One $(p_2,\gamma)$ correlation shows a 20% anisotropy in the plane perpendicular to the direction taken by the recoil nucleus, while another $(p_2,\gamma)$ correlation is essentially isotropic. (auth)

**17830**

STUDY OF $(\gamma,n)$ AND $(\gamma,f)$ REACTIONS OF $Th^{232}$ BY RADIO-CHEMICAL METHOD WITH $\gamma$ QUANTUM ENERGY UP TO 13 Mev. N. P. Avdonin and K. A. Petrzhak (Lensovet Inst. of Tech., Leningrad). Trudy Leningrad. Tekhnol. Inst. im. Lensoveta 40, 5-15(1957). (Translated from Referat. Zhur. Khim. No. 2, 1958, Abstract No. 3480)

Photoreactions of $Th^{232}$ were studied. A betatron was used as the source of $\gamma$ radiation. The Th specimens were irradiated with $\gamma$ quanta of $7 \leq E \leq 13$ Mev. The number of fission events was measured by the activity of $Mo^{99}$ and $Ce^{143}$ with $T_{1/2}$ = 67 and 33 hours respectively. The integral cross section ratio of two concurring processes—photofission and photoneutron emission—was measured. Radioactive chains with mass numbers 143, 117, 113, 99, 97, and 91 were separated.

**17831**

REACTIONS IN SOME LIGHT NUCLEI WITH PARTICIPATION OF DEUTERONS AND TRITONS. T. Kopaleyshvili. Trudy Tbilis. Univ. 62, 83-102(1957). (Translated from Referat. Zhur. Khim., No. 2, 1958, Abstract No. 3479)

Stripping reactions, (d,p) and (d,n), in light nuclei are investigated. A computation method taking the inner nucleus region into consideration is offered. Reactions with deuteron participation, as well as (d,t) reactions, for $Be^9$ and $C^{13}$ are discussed. As far as $Be^9$, $C^{13}$, $O^{17}$, $N^{13}$, and $F^{17}$ nuclei are concerned, they are considered as consisting of skeleton nuclei + one unpaired nucleon connected with each.

**17832**

ON $As^{76}$ EMISSION. Ye. P. Grigor'yev, L. V. Gustova, A. V. Zolotavin, et al. Vestnik Leningrad Univ. No. 10, 37-9(1957). (Translated from Referat. Zhur. Khim. No. 2, 1958, Abstract No. 3477)

$\beta$ and $\gamma$ emissions of $As^{76}$ with $T_{1/2}$ = 26.75 hours are studied. The $\beta$ spectrum was studied with a $\beta$ spectrometer with double focusing. The $\gamma$ emission of $As^{76}$ was measured with a magnetic spectrometer for measuring the hard $\gamma$ emission by recoil electrons. 5 $\beta$ lines and 6 $\gamma$ lines were revealed. Their energy is as follows: $350 \pm 30$, $880 \pm 100$, $1760 \pm 40$, $2410 \pm 30$, $2960 \pm 20$ kev and $1.21 \pm 0.02$, $1.43 \pm 0.03$, $1.77 \pm 0.04$, $2.10 \pm 0.03$, $2.42 \pm 0.04$ Mev respectively.

**17833**

THE EFFECTIVE CROSS SECTION OF THE $(\gamma,p)$ REACTIONS IN Mn, Cu, AND Sb. W. Lohmann (Univ. of Freiburg i. Br.). Z. Naturforsch. 13a, 701-3(1958) Aug. (In German)

The effective cross sections of $(\gamma,p)$ reactions were measured in Mn, Cu, and Sb. The values obtained were $(5.1 \pm 1) \times 10^{-27}$, $(8.5 \pm 2) \times 10^{-27}$, and $(1.7 \pm 1) \times 10^{-27}$ $cm^2$, respectively. On the basis of the various errors possible in the measurements it was estimated that these values are accurate to ca. 30%. The results were compared with those predicted by the statistical theory of the nucleus. (J.S.R.)

**17834**

SECONDARY NUCLEAR REACTIONS IN BISMUTH AND LEAD INDUCED BY HIGH ENERGY PROTON BOMBARDMENT. B. V. Kurchatov, V. N. Mekhedov, L. V. Christyakov, et al. Zhur. Eksptl'. i Teoret. Fiz. 35, 56-63(1958) July. (In Russian)

The production of astatine isotopes (Z = 85) by bombardment of bismuth (Z = 83) and lead (Z = 82) with protons of energies up to 480 Mev was studied by a radiochemical method. The cross sections for $At^{211}$ and $At^{210}$ production on bismuth were found to equal $6 \times 10^{-29}$ and $2 \times 10^{-29}$ $cm^2$ respectively. The formation of light isotopes, $At^{210}$ and $At^{209}$ was established. $At^{211}$ was detected in lead ($\sigma \sim 10^{-31}$ $cm^2$). The phenomena observed are explained by assuming them to be the result of secondary reactions of capture of the disintegration products ($\alpha$-particles or lithium nuclei). Formation of light astatine isotopes is explained by high energy proton capture with subsequent emission of $\pi^-$ mesons and several neutrons. The cross section for production of $\alpha$-particles with E > 20 Mev from bismuth irradiated by 480 Mev protons was determined from the astatine yield and found to be 5 to $6 \times 10^{-25}$ $cm^2$. (tr-auth)

## Particle Accelerators

*Refer also to abstract 17947.*

**17835** ISC-927

Ames Lab., Ames, Iowa.

TESTS AND ANALYSIS OF MAGNETIC QUADRUPOLE LENSES. Philip J. Lynch and D. J. Zaffarano. Aug. 1957. 53p. Contract W-7405-eng-82. $1.50(OTS).

A pair of strong focusing magnetic lenses are used to focus the electron beam from the Iowa State College Synchrotron. Each lens has four poles, alternately north and south. An electron, directed away from the principal axis in, say, the horizontal plane of the lens, is therefore converged in the vertical plane. The two lenses are rotated 90 degrees with respect to one another, principal axes coincident, so that each electron is subject to both a converging and a diverging field, the order depending on the plane of initial entry. However, two equally strong convergent and divergent lenses produce a real image in both planes, for a suitable adjustment of parameters. In general, the images do not coincide, but for each value of the magnetic field, there is a unique source distance for coincident focusing. To determine the properties of these lenses, a current-carrying wire is employed. The wire, placed under a constant tension in the magnetic field, feels a force proportional to the strength of the field and the current. It adjusts to an equilibrium position, which is the trajectory of an electron with the corresponding magnetic rigidity. By noting the intersection of the wire with the principal axis of the lens' system, the image distance for any given object distance can be determined. If the object distance is infinite, the image distance will be the focal length. A theoretical analysis allows comparison with the experimental findings. Results from the focal length measurements show that the magnetic field does not cut off sharply at the face of a lens, but extends 2.0 cm beyond it. With this information taken into account, the agreement between theory and all experimental data is good. (auth)

**17836** UCRL-8346

California. Univ., Berkeley. Radiation Lab.

THE ELECTRICAL SYSTEM OF THE BEVATRON RAPID BEAM EJECTOR (BEAM-KICKER). Charles G. Dols. July 1958. 24p. Contract W-7405-eng-48. $4.80(ph OTS); $2.70(mf OTS).

The operation cycle of a bubble chamber includes a brief period during which charged particles entering the

chamber produce optimum tracks. Following the lead of Rahm at the Brookhaven Cosmotron, a group at the Berkeley Bevatron constructed a rapid beam ejector to produce brief pulses of particles. Energy stored in a capacitor bank is transferred to an air-core magnet surrounding the proton beam of the Bevatron. The protons are displaced from their normal orbit and strike a suitably located target; particles from this target can then emerge from the accelerator. A capacitor bank of 120μf stores 13,500 joules at 15,000 volts. Two ignitrons in parallel connect the capacitor to the magnet. The magnet current rises to the peak of 52,000 ampers in 55 microseconds; at peak current a resistor is connected in parallel to damp the current decay. (auth)

**17837**

STUDY OF A HIGH FREQUENCY ION SOURCE. De Lacoste and J. Salmon. Ann. phys. 3, 319-38 (1958) May-June. (In French)

A high frequency discharge tube, by making a small opening in the envelope and superposing on the high frequency field a continuous field in a suitable direction, could be used as a high frequency ion source. The design and construction of such a discharge tube and the experimental arrangement for examining it are described in detail. Measurements were made on the initial voltage, the pressure at the interior of the source, the high frequency power injected in the source, and the yield. The phenomena observed and the results are of the measurements are given. Theoretical explanations of the phenomena observed are discussed. (J.S.R.)

**17838**

THE MICROTRON AS A HIGH-ENERGY, HIGH CURRENT PARTICLE ACCELERATOR. Arthur Roberts (Univ. of Rochester, N. Y.). Ann. Phys. (N. Y.) 4, 115-65(1958) June.

It is proposed that the conventional electron microtron may be converted into a high-energy accelerator for protons or electrons in the Bev range, and capable of very high currents. It would require a high-energy injector, e.g., an FFAG cyclotron, capable of supplying protons of energy above 500 Mev in a beam of high intensity and high quality. The changes required are the introduction of Thomas focusing (sector fields), the use of linacs for acceleration, and the use of high-energy injection. The resulting accelerator uses fixed (and sometimes even uniform) magnetic fields, a fixed frequency r-f accelerating system with wavelength near 20 cm, and may be designed in one stage or in a cascade of two or more stages, each using a separate linac, with contiguous fields. It is capable of reaching arbitrarily high energies without betatron resonance difficulties, it possesses phase stability, and it provides a beam, remarkably homogeneous in energy, which may be easily and completely extracted from the machine, since successive orbits are well separated. The problems of orbit dynamics, linac design, betatron and phase oscillations, and cascade operation are discussed, and sample designs for a 3-Bev proton accelerator are given. The theory of synchronism in nonzero-gradient fields is presented. An analytic theory of phase oscillation is given. The name "auxinotron" is proposed for the new type of accelerator. (auth)

**17839**

NATURAL MODULATION OF HIGH FREQUENCY ION SOURCE BEAMS. G. C. Phillips, E. B. Paul, A. T. G. Ferguson, and A. B. Whitehead (Atomic Energy Research Establishment, Harwell, Berks., Eng.) and T. Grjebine, R. Moreau, and B. Olkowsky (Centre d'Etudes Nucleaires de Saclay, France). Nuclear Instr. 3, 43-4(1958) July.

There appears to be a high percentage modulation of the beams from the Harwell and the two Saclay Van de Graaff accelerators, and in each case the modulation has the principal frequencies of its ion source oscillator. Because of this characteristic it may be possible to increase the intensity of the pulsed beams produced by r-f deflection to produce very intense beams of short pulses at any desired repetition rate from a conventional ion source, and to measure the beam current intensities without stopping the beam. (J.R.D.)

**17840**

THE DECOUPLING ELEMENTS IN THE HF TRANSMISSION LINES OF A MICROTRON. H. Reich (Physikalisch-Technischen Bundesanstalt, Brunswick). Nuclear Instr. 3, 97-103(1958) Aug. (In German)

Three types of decoupling elements in the transmission line between magnetron and resonator of a microtron are investigated with respect to their power consumption and efficiency: a shunt resistance, an attenuator pad, and a ferrite isolator. The equations governing the VSWR and the power distribution ratios resonator/load are derived and compared with measurements. It is shown, that the shunt resistance rules out the attenuator. The uniline type used does not give a better power efficiency than the shunt resistance. There only remain the other advantages of a ferrite isolator: ease of installation, uncritical setting of the phase shifter, and better isolation of the magnetron in the case of flash-over. (auth)

**17841**

FIELDS IN SLANTED-GAP EXCITED RECTANGULAR DUCTS. J. Van Bladel (Midwestern Universities Research Association and Univ. of Wisconsin, Madison). Nuclear Instr. 3, 109-115(1958) Aug.

Some features of the electromagnetic field in a rectangular wave-guide, cut in two by a plane making an angle $\theta$ with the guide's longitudinal axis, are examined. The field is excited by a voltage applied across the two halves of the guide. Several values of $\theta$, frequency (between zero and cut-off), and aspect ratio of the cross-section are considered. The problem is of interest for the design of particle accelerators, and, with this particular application in mind, data are presented for the energy and momentum kicks which particles experience when crossing the gap. (auth)

**17842**

THE 160-kev DEUTERON ACCELERATOR OF THE I.N.F.N., MILAN SECTION. L. Colli, S. Micheletti, and C. Salvetti (Univ. of Milan and Istituto Nazionale di Fisica Nucleare, Milan). Nuovo cimento (10) 9, 538-46 (1958) Aug. 1. (In Italian)

The electrostatic accelerator of the Physics Institute of the University of Milan is described. This instrument was designed to be used as a 14 Mev neutron source by means of the reaction $D + T = \alpha + n + 17.587$ Mev. A total flux of $5 \times 10^9$ neutrons/sec can be obtained, with the accelerating potential of 150 kv. (auth)

**17843**

AN ION ACCELERATOR. L. A. Goncharskiy. Priborostroyeniye No. 2, 26-7(1958).

A description is given of an ion accelerator with one anode and a dual cathode. The anode is a flat nickel plate fastened on a molybdenum spring and the cathode is a glass-covered molybdenum wire. (J.S.R.)

## Radiation Absorption and Scattering

**17844** AFOSR-TN-58-730

Yale Univ., New Haven.

EFFECTS OF ATOMIC ELECTRONS ON p-p AND n-p SCATTERING. G. Breit. Aug. 15, 1958. 7p. Contract AF18(600)-771. (AD-162265).

Equations are developed which show that while electron screening effects in high-energy nucleon-nucleon scattering are small, in low-energy scattering they become significant enough to demand consideration. (D.E.B.)

**17845** NEVIS-62

Columbia Univ., Irvington-on-Hudson, N. Y.
Nevis Cyclotron Labs.

SCATTERING OF 37 MEV POSITIVE PIONS ON HYDROGEN (thesis). Benjamin A. Wooten. Feb. 1958. 31p. Contracts N6-ori-110, Task No. 1 and AT(30-1)-1932. (CU-165-58-ONR-110-1-Phys.). $6.30(ph OTS); $3.00 (mf OTS).

Measurements were made of the differential scattering cross sections of positive pions on hydrogen at 37 Mev using a liquid hydrogen target and scintillation counters. Scattered pions are separated from other particles in the background by measuring the mass and energy of the particles using a pulse height analysis on the signals from the scintillation counters. A partial wave analysis is made of the experimental results assuming S and P wave scattering. The results obtained are: $\alpha_3 = -4.11 \pm 1.09$ deg, $\alpha_{33} = 3.12 \pm 0.79$ deg, $\alpha_{31} = -0.32 \pm 0.73$ deg. (auth)

**17846** NP-6953

Connecticut. Univ., Storrs.

THE EFFECT OF TARGET GAS TEMPERATURE ON THE APPARENT DIFFERENTIAL SCATTERING CROSS-SECTION. Interim Technical Report. Arnold Russek. Sept. 15, 1958. 20p. DA Project 599-01-004. Contract DA-19-059-ORD-2702.

If a beam of particles is scattered by a gas or plasma, the apparent differential scattering cross-section observed experimentally is affected by the random thermal motion of the target particles. In order to explore the feasibility of using this effect as a means of measuring temperature, a theoretical study was made of the temperature dependence of the apparent cross-section. A general expression is obtained for the apparent differential cross-section (in terms of the differential cross-section in the center-of-mass frame) that would be observed if the target particles were all moving with the same speed, but in random directions. This general expression is simplified for the case in which the incident beam particles have negligible mass compared to the targets and in which the targets are moving slowly compared to the incident beam particles. It is found that the first order correction to the cross-section vanishes, so that the temperature dependence is a second order effect. Finally, the special case of Rutherford scattering is treated in this approximation, and the correction to the differential scattering cross-section is obtained in this case. (auth)

**17847** UCRL-2969

California. Univ., Berkeley. Radiation Lab.

ANGULAR DISTRIBUTIONS OF CHARGED PARTICLES FROM 31-MEV PROTONS ON CARBON (thesis). George J. Hecht. Apr. 21, 1955. 37p. Contract W-7405-eng-48. $6.30(ph OTS); $3.00(mf OTS).

Angular distributions of several groups of charged particles resulting from the bombardment of carbon with 31-Mev protons were obtained. The angular distribution of elastically scattered protons is in good agreement with the prediction of the Born approximation at forward angles. Diffraction effects are compared with the results at lower energies and show that the angles for which they occur are not strictly proportional to $\lambda\!\!\!^{-}/R$ over the energy range 10 to 31 Mev. The angular distributions of two inelastic proton groups from the reaction $p + C^{12} \rightarrow p' + C^{12*}$, leaving $C^{12*}$ with 4.43 and 9.60 Mev excitation, were analyzed in accordance with the theory of Austern, Butler, and McManus. The theory apparently is inadequate for the 4.43-Mev level, in which both total angular momentum and parity for initial and final states are known. The shape of the angular distribution of the scattered protons corresponding to the 9.60-Mev level agrees with the theory and leads to an assignment of $J' = 0^-, 1^-$, or $2^-$. A deuteron group from the reaction $p + C^{12} \rightarrow d + C^{11}$ has been identified and the angular distribution has been compared with the stripping theory of S. T. Butler by means of the principle of detailed balancing. The agreement found indicates that the ground state of $C^{11}$ is characterized by $J = {}^3/_2{}^-$. (auth)

**17848** UCRL-8427

California. Univ., Berkeley. Radiation Lab.

UNSTABLE PARTICLES AS TARGETS IN SCATTERING EXPERIMENTS. G. F. Chew and F. E. Low. Aug. 21, 1958. 34p. Contract W-7405-eng-48. $6.30 (ph OTS); $3.00(mf OTS).

A general method is suggested for analyzing the scattering of particle A by particle B, leading to three or more final particles, in order to obtain the cross section for the interaction of A with a particle which is virtually contained in B. Binding complications are absent if a plausible assumption about the location and residues of poles in the S-matrix is accepted. The method is useful for unstable particles from which free targets cannot be made; the special examples of pion and neutron targets are discussed in detail. (auth)

**17849**

ELASTIC SCATTERING OF HIGH ENERGY ELECTRONS BY $C^{12}$ NUCLEI. Sin-nan' Tszin' and (Inst. of Physics, Acad. Sinica., China) Chzhen-i Khuan. Acta Sci. Natur. Univ. Pekinensis No. 1, 89-95(1957). (Translated from Referat. Zhur. Fiz. No. 1, 1958, Abstract No. 422)

A method is given for the analysis of experiments on the elastic scattering of high energy electrons by $C^{12}$ nuclei. For the distribution of charge in $C^{12}$ (a) an exponential model and (b) a homogeneous model are assumed. By analysis of the data for 187 Mev, it was concluded that the charge distribution in the $C^{12}$ nucleus is intermediate between (a) and (b).

**17850**

CALCULATION OF THE TRANSMISSION FACTOR IN X-RAY SCATTERING. M. Sawada and C. H. Shaw (Ohio State Univ., Columbus). J. Appl. Phys. 29, 1344-7(1958) Sept.

Analytical equations have been derived for the transmission factor applicable to the case of a rather weakly absorbing sample of circular cross section and larger than the x-ray beam. Calculations are presented for liquid nitrogen, and it is shown that under certain practicable conditions the transmission factor is constant for a rather wide range of the scattering angle. (auth)

**17851**

SCATTERING OF FAST PROTONS BY NON-SPHERICAL NUCLEI. S. I. Drozdov. J. Nuclear Energy 7, 231-8 (1958) Sept.

There is a substantial difference between the angular

distributions of protons scattered by spherical and by non-spherical nuclei, and by comparing theoretical calculations with experiment the deviation of a nucleus from a spherical shape can be estimated. The scattering of fast protons by non-spherical nuclei is considered for the case where the proton energy is large compared with the Coulomb barrier energy (E > 20 Mev). Further, a 'black' model of the nucleus and the adiabatic approximation are also assumed; then the effective scattering cross-sections can be found by determining the amplitude for scattering by a fixed nucleus. It is shown that the amplitude can be represented as a sum of the amplitudes for diffractive scattering and for scattering by the electric field of the nucleus. Both these amplitudes are derived assuming that the deviation of the nucleus from spherical shape is small ($\alpha_2 Ze^2/\hbar v \ll 1$). The angular distributions of protons scattered by even-even nuclei are evaluated. (auth)

**17852**

STATISTICAL THEORY OF THE ANGULAR DISTRIBUTION OF FISSION FRAGMENTS. V. M. Strutinsky. J. Nuclear Energy 7, 239–46(1958) Sept.

The angular distribution of fragments is considered in the case where fission takes place at an excitation energy high enough for the momentum to be distributed among a large number of nucleons, so that the statistical theory of the nucleus applies. The distribution of the states of the "transitional" nucleus over K, the projection of the angular momentum of the compound nucleus along the fission axis, is calculated. The most probable state is that with K = 0, which in the case of neutron-induced fission leads to maxima at 0 and 180° in the angular distribution of the fragments. These results are compared with experiment, and the moment of inertia of the "transitional" nucleus about the symmetry axis (the direction of fission) determined thereby. Consideration is also given to the angular distributions resulting from fission induced by charged particles and γ-quanta. (auth)

**17853**

RESONANCE SCATTERING OF $^{24}$Mg γ-RAYS. N. A. Burgov and Yu. V. Terekhov. J. Nuclear Energy 7, 247–54(1958) Sept.

Resonance scattering of the 1.38 Mev γ-ray from $Mg^{24}$ was observed in metallic magnesium by means of a transmission measurement. The 1.38 Mev radiation is due to a transition from the first excited level to the ground state. The small loss of energy experienced by the γ-ray quantum owing to nuclear recoil at the time of emission and to subsequent collisions with nuclei is compensated, in some instances, by an energy increment, due to the velocity which the emitting nucleus has in virtue of the earlier emission of a 2.76 Mev γ-ray. Quanta of the correct energy for resonance scattering are therefore to be found in the decay radiation. Fast coincidences between γ-rays of the two energies, emitted by an aqueous solution of $NaOh^{24}$, were detected by a method involving pulse amplitude analyzers, and the transmission of the 1.38 Mev γ-ray by Mg and Al scatterers was measured as a function of the angle between the radiations. At an angle of 120°, agreeing with theory, a dip of half-width ~2½° was found in the transmission of Mg. The measurements set a lower limit for the width of the 1.38 Mev level of $Mg^{24}$ at $3.2 \times 10^{-4}$ ev. (auth)

**17854**

AN IMPULSE APPROXIMATION FOR THE DEUTERON STRIPPING REACTION. G. Rakavy (Hebrew Univ., Jerusalem). Nuclear Phys. 7, 553–60(1958) Aug.

Deuteron stripping at low and intermediate energies is treated in a way resembling the impulse approximation. The neutron-proton interaction is considered twice: first it determines the initial conditions of the problem and then this same interaction is considered as a perturbation inducing transitions between various eigenstates determined by the strong interaction of the target nucleus with the impinging particles. The nuclear parameters entering the calculation are, besides the reduced widths, the scattering amplitudes of free neutrons and protons. In the present treatment, room is made for some resonance phenomena. Also the effect of the Coulomb forces can be treated in a rather straightforward manner. (auth)

**17855**

SOME POSSIBLE EXPERIMENTS FOR THE INVESTIGATION OF INELASTIC SCATTERING OF NUCLEONS. L. M. Soroko (Joint Inst. of Nuclear Research, Dubna, U.S.S.R.). Nuclear Phys. 7, 579–90(1958) Aug.

Some possible experiments are considered which can be used to study inelastic collisions of nucleons of the type $N + N \rightarrow \pi + N + N'$. Processes of this type are most frequent in the ≈650 Mev energy region. Some nontrivial experiments on the π-meson-nucleon angular correlation are indicated which are based on the existence of azimuthal asymmetry in the emission of these two particles. Similar effects for a polarized nucleon beam are considered. The calculations are performed in terms of ten inelastic transition amplitudes, it being assumed that these transitions yield the main contribution to the total cross section of the $N + N \rightarrow \pi + N + N'$ process at 650 Mev. (auth)

**17856**

ELASTIC SCATTERING AND INTRINSIC STRUCTURE OF ELEMENTARY PARTICLES. D. I. Blohincev, V. S. Barašenkov, and V. G. Grišin (Joint Inst. for Nuclear Research, Dubna). Nuovo cimento (10) 9, 249–57(1958) July 16.

Experimental data on elastic scattering of $\pi^-$ mesons on protons with energy E = 1.3 Bev have been analyzed. It is shown that from the analysis of their angular distribution it is possible to determine the root mean square radius and to get the data about the distribution of matter inside the nucleon. The root mean square pion radius is found to be equal to $\sqrt{\langle r^2 \rangle} = (0.82 \pm 0.06) \times 10^{-13}$ cm. In conclusion a possible experimental criterion of the existence of an elementary length is considered. (auth)

**17857**

SOFT X-RAY ABSORPTION BY MANGANESE AND MANGANESE OXIDE. Bipin K. Agarwal and M. Parker Givens (Univ. of Rochester, N. Y.). Phys. and Chem. Solids 6, 178–9(1958) Aug.

Experimental curves are given which show the absorption properties of manganese and manganese oxide in the soft x ray region between 45 and 60 ev. Both substances show an absorption edge near 50 ev. On the low-energy side of the edge, the oxide has a larger absorption coefficient than the metal. (auth)

**17858**

PROTON ANGULAR DISTRIBUTIONS FROM $Cr^{52,53}$ (d,p) REACTIONS. A. J. Elwyn and F. B. Shull (Washington Univ., St. Louis). Phys. Rev. 111, 925–8(1958) Aug. 1.

Targets enriched in $Cr^{52}$ and $Cr^{53}$ were bombarded with 10-Mev deuterons. Angular distributions were measured and Q values determined for four proton groups from $Cr^{52}(d,p)Cr^{53}$ and for six groups from

$Cr^{53}(d,p)Cr^{54}$. For the former reaction the Q values were 5.74, 5.17, 4.77, and 3.43 Mev. For the latter the Q values were 7.55, 6.69, 6.24, 4.88, 4.36, and 3.76 Mev. All angular distributions were of type $l_n = 1$ except for Q = 4.77 Mev in $Cr^{52}(d,p)$, for which $l_n = 3$. The latter group is interpreted as possibly a single-particle $f_{5/2}$ state, and these data may therefore reveal the relative position of single-particle $f_{5/2}$ and $p_{3/2}$ levels. (auth)

**17859**

VARIATIONAL METHODS IN SCATTERING PROBLEMS. Mildred Moe and David S. Saxon (Univ. of California, Los Angeles). Phys. Rev. 111, 950-7(1958) Aug. 1.

Modifications of the Hulthén-Kohn variational principle are introduced with the hope of increasing the usefulness of variational methods. Although no simple formulation of general utility is found, it is shown that there exists a great variety of stationary expressions which make possible a greater freedom in the choice of variational principles than has hitherto been demonstrated. Some criteria for the selection of special forms are discussed. (auth)

**17860**

ENERGY LOSS OF FAST CHARGED PARTICLES IN LiH. Werner Brandt (E. I. DuPont de Nemours and Co., Inc., Wilmington, Del.). Phys. Rev. 111, 1042-6 (1958) Aug. 15.

The quantum theory of the electromagnetic interaction of particles and fields in dense matter predicts that fast charged particles lose their kinetic energy to longitudinal electronic excitations influenced by one-electron and collective effects. Both effects are to be expected in metals and insulators, but to varying degrees. A clear identification of collective excitations in insulators is still lacking. LiH is the best-suited crystal for predicting the one-electron and collective effects on the longitudinal electronic excitations in an insulator, and for verifying such prediction experimentally. The characteristic energy loss spectrum and the mean excitation potential of the LiH crystal are estimated. One finds that the longitudinal excitations in this insulator crystal are of predominantly collective character. The results are so significantly different from those obtained by neglecting collective effects that stopping experiments in single as well as in multiple scattering can clearly identify the collective effects and confirm the theoretical predictions. (auth)

**17861**

NUCLEON-NUCLEON INTERACTIONS AND POLARIZATION OF HIGH-ENERGY PROTONS ELASTICALLY SCATTERED FROM CARBON. Shoroku Ohnuma (Yale Univ., New Haven). Phys. Rev. 111, 1173-8(1958) Aug. 15.

The transition matrix element in momentum space derived by Riesenfeld and Watson was used to calculate the polarization and the triple-scattering parameter $\beta$ of high-energy protons elastically scattered at small angles from carbon. As the nucleon-nucleon phase shifts which represent two-body interactions, those by Signell and Marshak, by Gammel and Thaler, and by Feshbach and Lomon were considered. In evaluating nuclear as well as Coulomb scattering amplitudes, the first Born approximation was employed with the assumption that, in carbon, the distribution of protons is equal to that of neutrons. Final results are then independent of the assumed distribution of nucleons. It was found that, while one cannot discriminate between Signell-Marshak and Gammel-Thaler phase shifts, both of them being in semiquantitative agreement with experimental data, Feshbach-Lomon phase shifts may be ruled out because of the wrong sign of the resulting $\beta$. Since only the first-order transition matrix element in momentum space was used, the calculation does not depend on the optical model potential in the usual sense. (auth)

**17862**

PROTON-PROTON SCATTERING IN THE Bev REGION. G. E. Brown (Univ. of Copenhagen). Phys. Rev. 111, 1178-81(1958) Aug. 15.

Proton-proton scattering in the Bev region is analyzed in terms of an interaction which, at 1 Bev, is taken to be a hard core of radius $0.45 \times 10^{-13}$ cm together with an external absorption of Gaussian form. The hard core is assumed to disappear with increasing energy and to be replaced by absorption. General features of the data are well reproduced by this simple model. (auth)

**17863**

EFFECTS OF ATOMIC ELECTRONS ON p-p AND n-p SCATTERING. G. Breit (Yale Univ., New Haven, Conn.). Phys. Rev. Letters 1, 200-3(1958) Sept. 15.

The desirability of considering the problem of electron screening in p-p and n-p scattering more fully is pointed out. The recoil of nuclei caused by electron ejection is considered. (W.D.M.)

**17864**

EXPERIMENTAL TEST OF TIME-REVERSAL INVARIANCE IN STRONG INTERACTIONS. A. Abashian and E. M. Hafner (Univ. of Rochester, N. Y.). Phys. Rev. Letters 1, 255-6(1958) Oct. 1.

A comparison of the polarization (P) and the asymmetry (A) in the scattering of protons by nuclei can be used as a test of invariance under Wigner time reversal in the nuclear interaction. P and A were independently measured in p-p scattering at 210 Mev and 30°c.m. A liquid hydrogen target of thickness 0.8 $g/cm^3$ was used, and carbon was employed both as a polarizer in the A measurement and as an analyzer in the P measurement. Results yield values of $A = 0.308 \pm 0.005$ and $P = 0.279 \pm 0.017$. (W.D.M.)

**17865**

POLARIZATION EFFECTS IN CASCADE SHOWERS. L. F. Cook, Jr. and N. Williams, Jr. (Univ. of California, Berkeley). Phys. Rev. Letters 1, 262-3(1958) Oct. 1.

The possibility of the "transmission" of polarization effects through matter by means of electromagnetic cascade showers has been suggested. If the showers are generated by polarized high-energy electrons, this effect can be used to measure the polarization of the incident electron beam by observing the resulting bremsstrahlung photons. Preliminary calculations for the effect were made by means of a Monte Carlo technique. The final results obtained were the numbers, polarizations, and energies of electrons, positrons, and photons after traversing a particular distance in the material. (W.D.M.)

**17866**

THERMAL INELASTIC COLLISION PROCESSES. M. J. Seaton (Univ. of London). Revs. Modern Phys. 30, 979-91(1958) July.

A summary of relevant collision theory methods is presented. Then heavy particle collisions are discussed. This includes excitation of H 1s hyperfine structure

states by H atom impact, excitation of $H_2$ rotation by H and $H_2$ impact, H 2s → 2p transitions produced by proton impact, charge exchange reactions, and excitation of atomic levels by proton impact. The use of the Born and distorted wave approximations for a description of inelastic collisions between atoms and electrons is discussed. Calculations of cross sections for excitation of forbidden lines in $p^q$ configurations are reviewed and new results are presented for $O^{2+}$, $N^+$, $C^+$, and $Si^+$, both variational and semi-empirical methods being used. New results are also given for photoionization from $2p^q$ configurations. (auth)

**17867**

THE DAILY COURSE AND THE DAILY SUMS OF SCATTERED AND TOTAL RADIATION ON SLOPES OF DIFFERENT ORIENTATIONS. K. Ya. Kondrat'yev and M. P. Manolova. Vestnik Leningrad. Univ. Ser. Fiz. i Khim. (No. 1) No. 4, (1958).

Pyranometric measurements were made of scattered and total radiation on surfaces of different orientations. The measurements were made on cloudless days in the summer of 1956 at the Karadag observatory. Surfaces with gradients of 5, 10, 15, 20, 30, 50, 70, and 90°, which were directed towards the south, north, east, and west, were measured. It was found that the amount of total or scattered radiation on a cloudless day depends only on the position of the sun and the direction of the slope. An analysis of the results also showed that for slopes of not more than 10° the curves of the total and scattered radiation show only minor modifications in different parts of the world. For steep slopes, however, a difference was observed in the curve of total radiation for different parts of the world. (J.S.R.)

**17868**

SCATTERING OF SLOW NEUTRONS ON DEUTERONS. V. N. Efimov (Lebedev Inst. of Physics, Academy of Sciences, USSR). Zhur. Eksptl'. i Teoret. Fiz. 35, 137-42(1958) July. (In Russian)

Neutron scattering lengths on deuterons were computed by the variational method with account of deuteron deformation. The radial dependence of the nuclear force potential was chosen in the form of a Gaussian curve, with parameters which agree with the data on n–p-interaction at low energies. The calculation is performed only for exchange forces of the Serber type. Within the experimental errors the scattering length values agree with the experimental values. (tr-auth)

**17869**

ON THE PROTON-PROTON SCATTERING IN $^1D_2$ STATE AT 616 Mev. L. M. Soroko (Joint Inst. of Nuclear Research). Zhur. Eksptl'. i Teoret. Fiz. 35, 276-7(1958) July. (In Russian)

The following processes are observed (when only processes of one π-meson production are investigated without consideration for the π meson d state); (1) elastic (p-p) scattering; (2) transition $^1D_2 \rightarrow (^3S_1p)_2$ in the reaction $p + p \rightarrow d + \pi^+$; (3) transition $^1D_2 \rightarrow (^3S_1p)_2$ in the reaction $p + p \rightarrow n + p + \pi^+$; (4) transition $^1D_2 \rightarrow (^3P_2s)_2$ in the reaction $p + p \rightarrow \pi^0 + p + p$. (R.V.J.)

## Radiation Effects

*Refer also to abstracts 17286, 17322, 17341, and 17371.*

**17870** ANL-5854

Argonne National Lab., Lemont, Ill.

"PIN-CUSHION" IRRADIATION TESTS OF URANIUM–CHROMIUM ALLOYS. S. H. Paine and F. L. Brown. July 1958. 21p. Contract W-31-109-eng-38. $0.75 (OTS).

Irradiation tests on small pins of wrought and heat-treated $U^{235}$-Cr alloys mounted in special heat transfer blocks or "cushions" are described. Three compositions, estimated at 0.03, 0.07, and 0.22 wt. % Cr, were tested in three metallurgical conditions: alpha-annealed, beta-quenched, and isothermally transformed. Radiation damage to the specimens having the first two heat treatments was very similar to that observed in unalloyed uranium of comparable history, and the isothermally treated specimens were similar to beta-annealed uranium in behavior. In spite of this essentially null result, which is associated with failure to obtain grain refinement in the specimens, there is evidence that under proper conditions chromium additions to uranium may be beneficial. (auth)

**17871** NP-6936

Battelle Memorial Inst. Radiation Effects Information Center, Columbus, Ohio.

MONTHLY ACCESSION LIST NO. 15 [ON RADIATION EFFECTS DATA]. Sept. 15, 1958. 30p. Project No. 2133. Contract AF33(616)-5171.

**17872**

PRODUCTION OF CARRIER-FREE $I^{131}$ BEGINNING WITH TELLURIC ACID. R. Constant (Centre d'Etudes Nucléaires, Mol-Donk, Belgium). J. Inorg. & Nuclear Chem. 7, 133-9(1958) Aug.-Sept. (In French)

The method uses telluric acid ($H_6TeO_6$) as a target for the production of $I^{131}$ in nuclear reactors. The experiments indicate that it is sufficient to dissolve the target in water in presence of a strong acid and to distill in order to carry over the iodine as $I^-$ and $I_2$. The method eliminates the difficulties of target dissolution and makes it possible to obtain a very pure distillate after an easily performed separation. It is possible to use the sulfuric and phosphoric acids indefinitely but an excess of either acid increases the distillate acidity. The irradiations were carried out in the BR 1 reactor at Mol in a thermal flux of about $10^9$ to $2 \times 10^{12}$ neutrons/$cm^2$/sec in temperature conditions never exceeding 90°C. The valency-state of the distilled iodine seems to be independent of the flux and of the integrated flux to which the target is submitted. Apparatus and production method are described. (auth)

**17873**

ELECTRON SPIN RESONANCE SPECTRA OF SOME γ-IRRADIATED POLYMERS. R. J. Abraham and D. H. Whiffen (The University, Birmingham, Eng.). Trans. Faraday Soc. 54, 1291-9(1958) Sept.

The electron spin resonance spectra of a number of γ-irradiated polymers, mostly of the polyvinyl series, were measured. The results are tabulated and the spectra are shown. The appearance of a new spectrum on introducing air was noted in some cases. A few tentative interpretations of the hyperfine patterns are made. (auth)

**17874**

THE DECOMPOSITION OF SOLID NITRATES BY X-RAYS. J. Cunningham and H. G. Heal (Queen's Univ. of Belfast). Trans. Faraday Soc. 54, 1355-69(1958) Sept.

The yield of nitrite in the decomposition by x-rays of the alkali nitrates, strontium nitrate, barium nitrate and silver nitrate has been measured. In several cases the variation of yield with temperature has been investigated. Potassium nitrate has been irradiated up to high

percentage decompositions and at a variety of temperatures. The changes in infra-red absorption spectrum and x-ray diffraction pattern of nitrates due to irradiation are described. (auth)

**17875**

THE EFFECTS OF RADIATION ON MATERIALS. J. J. Harwood, Henry H. Hausner, J. G. Morse, and W. G. Rauch, eds. New York, Reinhold Publishing Corporation, 1958. 361p.

Papers given at a Colloquium on "The Effects of Radiation on Materials," sponsored by the Office of Naval Research jointly with the Martin Co., at Johns Hopkins Univ., Baltimore, March, 1957, are presented. These papers deal with metals, alloys, inorganic dielectrics, semiconductors organic and polymeric materials, and materials for reactor components including fuel elements, moderators, coolants, and shielding materials. Theories and concepts of radiation effects, radiation sources, and measurements of radiation, and the known effects of radiation on the physical, metallurgical, mechanical, corrosion, and electrical properties are presented. (W.D.M.)

## Radioactivity

**17876**

MEASUREMENT OF THE $\beta$ AND $\gamma$ ACTIVITY FROM FALL-OUT. Herbert Schmier. Atomkern-Energie 3, 346-50(1958) Aug.-Sept. (In German)

Measuring methods and measured results of the $\beta$ activity from fall-out at Giessen and Laubach, Germany, are given. It was established that the $\beta$ activity per $cm^3$ fall-out was over the maximum permissible amount for constant administration. The average monthly value in July 1957, was twice as large as in October 1956. The average value of the daily $\beta$ activity per $m^2$ of collecting surface increased in the same time period by a factor of three. In order to detect a single component of the fission product mixture, the $\gamma$ energy spectrum of rain water residue was obtained with a single-channel scintillation spectrometer and later with a commercial four-channel spectrometer. The measurements were made in the energy range from 20 kev to 1 Mev. The spectra of residues with an activity of at least $10^{-3}$ $\mu c$ could be obtained with statistical accuracy. The isotopes $Ce^{141}$, $Ce^{144}$, $I^{131}$, $Ru^{103}$, $Zr^{95}$, and $Nb^{95}$ were detected. An exact determination of $Ba^{140}$ and $Nd^{147}$ was not possible. The dependence of the spectra on the age of the residues confirmed the results. (tr-auth)

**17877**

SUPPLEMENT TO THE ANTIPROTON SCHEME OF BETA DECAY. Lubor David. Ceskoslov. Casop. Fys. 7, No. 3, 248-9(1957). (Translated from Referat. Zhur. Fiz. No. 1, 1958, Abstract No. 448)

The possible schemes of beta decay of nucleons and antinucleons are given with allowance for the conservation of spin and under the assumption that the spin of the neutrino is $\frac{1}{2}$ and that of the anti-neutrino is $-\frac{1}{2}$.

**17878**

ANGULAR CORRELATION OF GAMMA QUANTA, EMITTED BY MESONIC ATOMS. V. A. Dzhrbashyan. Izvest. Akad. Nauk Armyan S. S. R. Ser. Fiz.-Math. 10, No. 2, 81-8(1957). (Translated from Referat. Zhur. Fiz. No. 1, 1958, Abstract No. 370)

The value of the anisotropy $A = W(180)/W(90) - 1$ for two gamma quanta, radiated by $\mu$ mesonic atoms upon successive transitions of the meson from one level to another is derived. ($W(\theta)$ is the probability of successive radiation of quanta making an angle $\theta$.) The calculation is made for medium and heavy mesic atoms, for which the dipole electric transitions play the principal part. Account is taken of the influence of the fine and hyperfine structure on the anisotropy and also of the finite dimensions of the nucleus. The quantity R which depends both on the spin s of the meson and on the spin I of the nucleus, is proposed for use in the experimental determination of the spins of the nuclei and the mesons. The results of the calculations are given for medium and heavy mesonic atoms.

**17879**

ANGULAR CORRELATION OF MONOPOLAR PAIRS OF CALCIUM 40. S. Gorodetzky, P. Chevallier, R. Armbruster, A. Gallmann, and G. Sutter (Inst. de Recherches Nucleaires, Strasbourg). Nuclear Phys. 7, 672-6(1958) Aug.

The angular correlation of the internal pairs from the first excited level (3.35 Mev) of $Ca^{40}$ obtained in a (p, p') reaction confirms that the transition from this level to the fundamental level $0^+$ has the character of an electric monopole (E0). (auth)

**17880**

NOTE ON THE DECAY OF $^{82}Sr$. V. Sangiust (Istituto di Fisica Sperimentale del Politecnico, Milan). Nuovo cimento (10) 9. 446-50(1958) Aug. 1.

$\gamma$ and x radiation accompanying the decay of $Sr^{82}$ were investigated. $\gamma$ rays of 775 and 1400 kev were found. $Rb^{82}$ daughter of $Sr^{82}$, is shown to decay through $\beta^+$ emission, not only to the ground state but also to excited levels of $Kr^{82}$. (auth)

**17881**

POSSIBLE EXPERIMENTS FOR DETERMINATION OF BETA INTERACTIONS. II. M. Morita and R. S. Morita (Columbia Univ., New York). Phys. Rev. 111, 1130-7 (1958) Aug. 15.

In Part I of this series some possible recoil experiments were proposed to decide the relative strength of scalar and vector interactions and that of tensor and axial vector interactions in beta decay. The formulas in the analysis of these experiments were given for decays involving beta-gamma cascades and K-capture gamma-gamma cascades. Here, similar formulas are given for decays involving beta-gamma-gamma cascades, taking into account the nuclear resonance fluorescence and circular polarization of the gamma ray. The decay of $Co^{60}$ is discussed in detail. The degree of the circular polarization of the resonant gamma ray from $Ni^{60}$ is 2% left-handed if the beta interaction is axial vector and 23% right-handed if tensor. (auth)

**17882**

THE TIME CONSTANTS OF SECONDARY EMISSION. H. W. Streitwolf and W. Brauer (Deutsche Akademie der Wissenschaften, Berlin). Z. Naturforsch. 13a, 700-1 (1958) Aug. (In German)

The response time $\tau$ of secondary emission is the time which passes between the penetration of the primary radiation into the emitter and the attaining of the stationary yield value. Van der Ziel (J. Appl. Phys. 28, 1216(1957)) stated that $\tau$ can be estimated on the basis of a single energy consideration. However, since the exterior distribution of the secondary emission is used instead of the interior distribution in the estimation of the number of excited secondary electrons, these results are not valid. A more accurate consideration of the energy balance is presented and the response time is calculated. (J.S.R.)

## Rare Earths and Rare-earth Compounds

**17883**
THE MAGNETIC PROPERTIES OF THE FERRITES OF YTTRIUM AND THE RARE EARTHS OF THE FORMULA $5Fe_2O_3 \cdot 3M_2O_3$. R. Pauthenet (Univ. of Grenoble, France). Ann. phys. 3, 424-62(1958) May-June. (In French)

The differences existing between the magnetic properties of the two rare earth ferrites, $Fe_2O_3 \cdot M_2O_3$ with perovskite structure and $5Fe_2O_3 \cdot 3M_2O_3$ with garnet structure, are described. This study is concerned with the garnet structure. At a given temperature, the magnetization is, in general, the result of a ferromagnetic term and a paramagnetic term. The variations of the spontaneous magnetization of the ferromagnetic term with the temperature presents a magnetic compensation point for the ferrites with Gd, Tb, Dy, Ho, Er, and Tm. The Curie points are in the neighborhood of 550°K. The magnetic properties of these ferrites are interpretated by a ferrimagnetic behavior of the iron ions on the sub-lattices a and d. In turn the magnetization resulting from these ions forms a ferrimagnetic grouping with that of the rare earth ions on the sub-lattice c. One can thus take account of the paramagnetic term. The values of the moments with absolute saturation show that the moments of the rare earth ions are partially blocked at low temperatures by a strong dissymetric crystalline field. The values of the coefficients of the molecular field representing the intensities of different interactions between magnetic ions were determined, and the curves of thermal variation of the spontaneous magnetization and the paramagnetic susceptibility were calculated. The values of the parameter u representing the interactions of exchange between two neighboring magnetic ions were deduced. The corresponding curve can be connected in a continuous fashion with the same curve traced by the metals. It defines the character of the superexchange interactions. (tr-auth)

## Spectroscopy

**17884** HW-21718(Del.)
Hanford Works, Richland, Wash.
EMISSION SPECTROSCOPIC ANALYSIS OF HYDROGEN–DEUTERIUM MIXTURES. J. A. Parodi, W. G. Burch, L. F. Kendall, and M. B. Leboeuf. July 30, 1951. Decl. with deletions Sept. 19, 1958. 29p. Contract W-31-109-eng-52. $4.80(ph OTS); $2.70(mf OTS).

The emission spectrometer procedure for the determination of the ratio 100 D/(H + D) in $H_2-D_2$ mixtures was calibrated for flow rates of ~5 cc STP per hour. Isobars of true composition vs. apparent composition were constructed for the composition range 89 to 100% $D_2$ and for pressures of 700, 800, 900, and 1000 $\mu$. It is concluded that the method is also applicable to the accurate analysis of $H_2-T_2$ mixtures. (auth)

**17885**
NUCLEAR MAGNETIC RESONANCE OF SODIUM–AMMONIA SOLUTIONS. Kenneth S. Pitzer (Univ. of California, Berkeley). J. Chem. Phys. 29, 453-4(1958) Aug.

**17886**
EFFECTIVE SYMMETRIES OF ELECTRICAL FIELDS ABOUT IONS IN SOLUTION. Donald G. Miller, Edward V. Sayre, and Simon Freed (Brookhaven National Lab., Upton, N. Y.). J. Chem. Phys. 29, 454-5 (1958) Aug.

The spectra of solutions of Eu, Gd, and Pr trichlorides in anhydrous methanol and in 80% water–20% methanol are shown and compared. (J.E.D.)

**17887**
SPECTROMETER FOR HEAVY PARTICLES. L. Bianchi, E. Cotton, and C. Mileikowsky (Centre d'Etudes Nucleaires, Saclay, France). Nuclear Instr. 3, 69-72 (1958) Aug. (In French)

For light nuclei reactions, the energy of the emitted particle depends appreciably on the emission angle with a double focusing spectrometer using a large entrance angle, this variation can be of several %. The experiments allowed to test for the first time this improvement of energy resolution with the astigmatic system (n = 0.57) and with a variable tilting angle of exit slit. (auth)

**17888**
TWO-CRYSTAL-COMPTON-SPECTROMETER WITH IMPROVED GEOMETRICAL EFFICIENCY. Peter Weinzierl and Georg Tisljar-Lentulis (Univ. of Vienna). Nuclear Instr. 3, 177-8(1958) Sept.

The low detection efficiency of the Compton spectrometer is disadvantageous in nuclear decay scheme work with low-level or short-life activities. Omitting the gamma-collimator and placing the source between the two crystals improves the efficiency. To reduce the number of gamma coincidences caused by primary quanta in the two crystals, relative to the Compton-scattering coincidences, a kicksorter was applied which accepts only those pulses from crystal 2 whose energy falls in the narrow band of back-scattered Compton quanta. The use of anthacene as the scattering crystal is advisable if the poorer resolution of this scintillator can be tolerated. This new version of the Compton spectrometer gives an increase of over-all efficiency by about two orders of magnitude. (A.C.)

**17889**
THE HIGH-ENERGY END OF THE ELECTRON-BREMSSTRAHLUNG SPECTRUM. M. V. Mihailovic (Inst. "J. Stefan," Ljubljana, Yugoslavia). Nuovo cimento (10) 9, 331-3(1958) July 16.

A calculation of the high-energy end of the electron bremsstrahlung spectrum is given, based upon Sommerfeld-Maue's approximation. The calculation leads to a non-zero limit of the cross section for $K \rightarrow E_0 - mc^2$, and the results are expected to be satisfactory except for heavy nuclei. (L.T.W.)

**17890**
VELOCITY FILTER FOR NUCLEAR SPECTROSCOPY. L. H. Th. Rietjens, O. M. Bilaniuk, and W. C. Parkinson (Univ. of Michigan, Ann Arbor). Rev. Sci. Instr. 29, 768-9(1958) Sept.

The background resulting from nuclear reaction products of the same magnetic rigidity as the particles to be magnetically analyzed is eliminated by preceding the magnetic analyzer by a velocity filter of crossed electric and magnetic fields. (auth)

**17891**
ABSORPTION SPECTRA OF GASEOUS ALKALI METAL HYDROXIDES AT HIGH TEMPERATURES. L. H. Spinar and J. L. Margrave (Univ. of Wisconsin, Madison). Spectrochim. Acta 12, 244-6(1958) Sept.

A modified Perkin-Elmer Model 81 single-beam recording infrared spectrometer was used for studies of gaseous hydroxides at temperatures up to 1000°. Characteristic absorptions were found for the equilibrium gases over NaOH, KOH and RbOH at wave-lengths in agreement with predictions made on the basis of a gaseous ionic model for $[MOH]_x$ (g). Gases over LiOH,

NaOH and KOH were examined in the visible and ultraviolet regions, but no absorption spectra were found. Na (g), in equilibrium with $[NaOH]_x$ (g), was first detectable at about 850°. (auth)

**17892**

ON ADJUSTING THE FIELD OF A MAGNETIC LENS SPECTROMETER WITH A LONGITUDINAL MAGNETIC FIELD. V. A. Sergiyenko. Vestnik Leningrad. Univ. Ser. Fiz. i Khim. (No. 1) No. 4, (1958).

The magnetic field of the lens and its effect on electron focusing in a magnetic field spectrometer were investigated. The electron trajectories in the longitudinal field were calculated, and methods of decreasing the spherical aberration were studied. (J.S.R.)

## Theoretical Physics

**17893** NP-6964

Joint Inst. for Nuclear Research, Moscow. Lab. of Theoretical Physics.

CONDITIONS OF SUPERFLUIDITY OF NUCLEAR MATTER. V. G. Soloviev. July 1958. 19p.

The methods developed in the theory of superconductivity are applied to the study of the properties of nuclear matter. The interaction that brings to superfluidity of nuclear matter was considered to be weak. Nucleon-nucleon interaction was taken in the most general form. Asymptotic solutions of equation system were found, which allowed to obtain the conditions of superfluidity of the nuclear matter. The conditions of superfluidity come in general to the requirement of predominance of attraction in nucleon-nucleon potentials at the Fermi surface energy. The data on nucleon-nucleon potentials allow to make conclusion that the conditions of superfluidity of nuclear matter are to be fulfilled. (auth)

**17894** NP-6966

Joint Inst. for Nuclear Research, Moscow. Lab. of Theoretical Physics.

ON A SUPERFLUID STATE OF THE ATOMIC NUCLEUS. V. G. Soloviev. 1958. 18p.

An investigation is made of the possibility of the appearance of a state of the atomic nucleus which will be energetically lower than the normal state. The above state is designated the superfluid state. The superfluid state is investigated using the Bogolubov variational principle, which is the generalization of the well-known Fock method by means of which mathematical methods are developed in the theory of superconductivity. A rather idealized model of the atomic nucleus is considered. Analogous calculations may be made for other nuclear models in which the interactions of all the nucleons are taken into account. The obtained results confirm considerations set forth in a previous study about the physical analogy between the Fermi-systems of metal and nucleus and illustrate the fruitfulness of application of the mathematical methods developed in the theory of superconductivity for studying the properties of the atomic nucleus. (A.C.)

**17895** UCRL-5335

California. Univ., Livermore. Radiation Lab.

THE SELF-CONSISTENT FIELD OF SINGLE-TYPE ELECTRONS IN A UNIFORM MAGNETIC FIELD. Lewi Tonks. Sept. 1958. 18p. Contract W-7405-eng-48. $3.30(ph OTS); $2.40(mf OTS).

A recently reported thermonuclear machine utilizes a cylindrical layer of relativistic electrons which, circulating to a uniform impressed magnetic field, are able to reverse that field in the interior. The complications of this situation are discussed, and it is pointed out that the only apparent avenue of progress lies in first stripping away all complications and then adding them to the problem as knowledge and concept are developed. The resulting analysis is concerned with a highly artificial situation but it is exact. (J.R.D.)

**17896**

ADJUSTMENT FOR NON-HOMOGENEITY OF FERMI'S KINETIC ENERGY OF PARTICLES WITH HALF-INTEGRAL SPIN. P. Czepfalusy (Academy of Sciences of Hungary). Acta Phys. Acad. Sci. Hung. 6, No. 2, 293-305(1956). (Translated from Referat. Zhur. Khim. No. 1, 1958, Abstract No. 22)

The expression of the atomic energy in the statistical theory with the introduction of Weizsaecker's adjustment modified by Gombas can be derived by the self-consistent field method of Hartree-Fok.

**17897**

TIME-INDEPENDENT NONRELATIVISTIC COLLISION THEORY. E. Gerjuoy (Univ. of Pittsburgh). Ann. Phys. (N. Y.) 5, 58-93(1958) Sept.

Arbitrarily complicated rearrangement collisions describable by the time-independent nonrelativistic Schrödinger equation are treated in a wholly time-independent framework, without explicit reference to transition probabilities. Introducing a generalized probability current operator for many-particle systems, the current flow at large distances can be computed in complete analogy with one-particle scattering. This procedure leads to the same formal expressions for reaction rates as are obtained from more conventional formulations; it is an immediate consequence of the asymptotic behavior of the Green's function that the matrix elements $\Psi_f^- * V_i \psi_i = \psi_f * V_f \Psi_i^+$ yield the scattering amplitude $A(i \to f)$, and that $\Psi_f^-$ is a solution with incoming scattered waves. Moreover the time-independent formulation avoids perplexities associated with the necessity for computing transition probabilities from projections on sets of nonorthogonal states. In the reaction $a + b \to c + d + e$ for instance it turns out automatically, without projecting the solutions on plane wave states, that coincidences are observed in counters placed at large distances $r_c$, $r_d$, $r_e$ only when $r_c$, $r_d$, $r_e$ are in the ratios of the classical velocities of c, d, e; here c, d, e are a rearrangement of the particles contained in a, b. These procedures can be applied either in the laboratory or center-of-mass systems; eliminating the center-of-mass coordinates does not simplify the calculations for three-body breakup $ab \to cde$. Reciprocity relations for two and three-body breakup are examined, and mathematical difficulties of this time-independent formulation are discussed. (auth)

**17898**

THE POLARIZATION OF DEUTERONS AND PARTICLES OF ARBITRARY SPIN. L. J. B. Goldfarb (Univ. of Manchester, Eng.). Nuclear Phys. 7, 622-42(1958) Aug.

General formulas are given for the polarization of particles of arbitrary spin which are emitted in a nuclear scattering or reaction process, and also for the angular distribution associated with processes involving incident particles of arbitrary spin that are polarized. These formulas are applied to the particular process of elastic scattering of deuterons by $He^4$ where a narrow resonance is found to exist at the deuteron laboratory energy of 1.069 Mev. This resonance is attributed to a well-defined intermediate state with a unique set of quantum numbers for the initial and final states. In general, the polarization of deuterons is described by tensors of first and

second rank; however in this case, the former tensors vanish while the tensors of second rank are independent of the nuclear matrix element and they attain large values for various scattering angles. Thus, the scattering process serves as an efficient polarizer of deuterons. Alternatively, it serves as an efficient analyzer of deuteron polarization of rank two. A calculation is made of the polarization of deuterons which are elastically scattered by spinless nuclei where the interaction is described by a potential. This potential is assumed to involve only the vector r, joining the center of mass of the deuteron to that of the nucleus, and the spins of the nucleons in the deuteron, $\sigma_p$ and $\sigma_N$. The most general potential involves central terms, V(r), spin-orbit terms of the type $W(r)\frac{1}{2}\hbar 1 \cdot (\sigma_p + \sigma_N)$, where 1 is the deuteron angular-momentum operator and tensor terms of the type $U(r)T_{12}$, where $T_{12} = 3\frac{\sigma_p \cdot r \sigma_N \cdot r}{r^2} - \sigma_p \cdot \sigma_N$. The polarization can be detected in a second scattering by the same nuclei or by using the $He^4$ scattering process as an analyzer. The calculation in Born approximation shows that in the latter case, the angular distribution when expressed as a function of the angle between the two scattering planes, shows a left-right asymmetry for tensor forces and no such asymmetry for spin-orbit forces. (auth)

**17899**

PHENOMENOLOGICAL ANALYSIS OF REACTIONS OF THE $a + a' \rightarrow b + b'$ TYPE. S. M. Bilenky, L. I. Lapidus, L. D. Puzikov, and R. M. Ryndin (Joint Inst. of Nuclear Research, Dubna, U.S.S.R.). Nuclear Phys. 7, 646-54 (1958) Aug.

Conditions for the construction from experimental data of the matrix for reactions of the $a + a' \rightarrow b + b'$ type are considered on basis of general principles of quantum mechanics. The reaction matrix M is expanded in a complete set of irreducible tensor operators $T^{JM}(j_b, j_a)$ and the number of complex scalar functions which determine it is computed for the case when invariance under space rotations and reflections is taken into account. Time reversal invariance of the interaction leads to relations between polarization effects in the direct and inverse reactions. The number of experiments required for complete construction of the reaction matrix in the presence of several channels can be determined on basis of unitarity of the S matrix. The general form of the azimuthal dependence of the angular distribution of the reaction products (for arbitrary spins) is derived. (auth)

**17900**

CONVERGENCE OF THE S-MATRIX. D. R. Yennie and S. Gartenhaus (Stanford Univ., Calif.). Nuovo cimento (10) 9, 59-76(1958) July 1.

An investigation is made of the convergence of the field-theoretic perturbation expansion of the elements of the S-matrix. For a theory characterized by a coupling linear in the boson field, it is established that if a cut-off is introduced in momentum space, then the transition amplitude for any given process over a finite-time interval, is bounded term by term by an exponential series. The extension of the method to interactions which are not linear is, for several cases, also included. The implications of the result for theories without a cut-off is discussed from a qualitative point of view. (auth)

**17901**

UNITARY TRANSFORMATIONS OF SYMMETRIC PS-PS AND PS-PV INTERACTIONS. J. S. R. Chisholm and G. M. Dixon (University Coll. of Wales, Cardiff). Nuovo cimento (10) 9, 125-35(1958) July 1.

Exact covariant unitary transformations applied to the Lagrangians of symmetric PS-PS and PS-PV theories exhibit the so-called equivalence of the pseudoscalar and pseudovector couplings. The transformation of the PS-PS theory is compared with similar transformations. The value of making unitary transformations is discussed, and some remarks on renormalization problems are made. (auth)

**17902**

CAUSALITY AND VACUUM POLARIZATION DUE TO A CONSTANT AND A RADIATION FIELD. A. Minguzzi (Univ. of Maryland, Washington, Univ. of Bologna, and Istituto Nazionale di Fisica Nucleare, Bologna). Nuovo cimento (10) 9, 145-53(1958) July 1.

It is shown that the modification of the vacuum due to the superposition of a constant electromagnetic field and a radiation field can be accounted for by a refraction index which is the limit to the real axis from the upper part of the complex plane of a function of the frequency analytic in the full complex plane with exception of branch points on the real axis. This function is explicitly constructed. It is shown that when the absorption is negligible, the phase velocity of the radiation field in the constant electromagnetic field region is smaller than the light velocity in vacuo. (auth)

**17903**

THE FORMULATION OF THE QUANTUM FIELD THEORY WITHOUT LAGRANGE FORMALISMS. W. Weidlich (Univ. of Erlangen, Germany). Nuovo cimento (10) 9, 228-48(1958) July 16. (In German)

It is investigated to what extent the quantum theory of elementary particles can be built up by using the following principle only: There exists an irreducible representation of the algebra of creation and annihilation operators $a^+$, a, and the infinitesimal transformations of the inhomogeneous Lorentz group can be constructed out of them. The representation of the inhomogeneous Lorentz group can then be split up in irreducible ones classified by Wigner and describing different sorts of elementary particles. Space-time dependence of all operators is introduced by a unitary transformation of $a^+$, a. Energy-momentum tensors and charge-current vectors are found without use of fields. Fields and field equations, corresponding to the various sorts of elementary particles, may also be set up but are dispensable. Interactions are introduced as unitary transformations of $a^+$, a, mixing the irreducible representations of the Lorentz group. This corresponds to in general non-local interaction terms in the Lagrange formalism. (auth)

**17904**

POLARIZATION OF PARTICLES WITH SPIN UNITY. C. B. Van Wyk (CERN, Geneva). Nuovo cimento (10) 9, 270-9(1958) July 16.

The $3 \times 3$ matrix which describes the polarization of a beam of particles with spin unity is discussed. The degree of polarization is defined and the type of polarization discussed in terms of the vector and tensor that occur in the matrix. It is shown that the vector tends to coincide with a principal axis of the tensor. The equivalence of the appropriate special case with the Stokes parameter treatment of the polarization of electromagnetic radiation is indicated. (auth)

**17905**

ON THE ANALYTIC BEHAVIOUR OF THE EIGENVALUE OF THE S-MATRIX IN THE COMPLEX PLANE OF THE ENERGY. T. Regge (Univ. of Turin and Istituto Nazionale di Fisica Nucleare, Turin). Nuovo cimento (10) 9, 295-302(1958) July 16.

A study on the analytic behavior of the eigenvalues of the S-matrix in the complex plane of the energy $E = k^2$ is carried out for the case of spinless non-relativistic particles scattered by a fixed center of force. A method is developed capable of finding in a finite number of steps any false zero or singularity of the eigenvalues of the S-matrix. The same method shows that in the upper k-plane Jost's f(k) function may have not only simple poles but also any kind of singularity. The method enables the establishment of the main features of these singular points. (auth)

**17906**

HEISENBERG'S UNIVERSAL THEORY AND GRAVITATION. J. Rayski (Jagiellonian Univ., Krakow, Poland). Nuovo cimento (10) 9, 337-9(1958) July 16.

Recently Heisenberg (Rev. Mod. Phys. 29, 269(1957)) proposed a simple nonlinear equation for a universal spinor field including all elementary particles as excited states of this field as well as their strong and electromagnetic interactions. The extension of Heisenberg's representation to gravitational fields is discussed. (L.T.W.)

**17907**

REMARKS ON SOME IDENTITIES IN STATIC MESON THEORY. K. Haller (Washington Univ., St. Louis). Nuovo cimento (10) 9, 346-9(1958) July 16.

**17908**

ON THE UNIVERSAL FERMI INTERACTION. S. A. Bludman (Univ. of California, Berkeley). Nuovo cimento (10) 9, 433-45(1958) Aug. 1.

The parity-non-conserving. V-A form of Fermi interaction is derived from a principle of invariance under a continuous group of transformations, in analogy with the ordinary gauge-invariance derivation of the minimal electromagnetic interaction of charged particles. This assumption is a stronger restriction on the form of Fermi interactions than that invoked by Sudarshan and Marshak, Gell-Mann and Feynman, and Sakurai, and leads to additional predictions that are subject to experimental check. If these transformations were symmetry transformations of the entire Lagrangian, then the $\beta$- and $\mu$-decay coupling constants would be precisely equal. The implications of extending this Fermi gauge invariance to a group depending on space-time functions is discussed. The possibility that Fermi interactions involving change of strangeness are unallowed is considered, and the results of assuming a universal Yukawa V-A parity-non-conserving interaction are tabulated. Such a Yukawa interaction, involving one new coupling constant, leads to reasonable K-meson and hyperon decay rates and allows $\pi$-meson decay into $\mu + \nu$ without any appreciable decay into $e + \nu$. (auth)

**17909**

CONSTRUCTION OF POTENTIALS FROM RESONANCE PARAMETERS. T. Regge (Univ. of Turin and Istituto Nazionale di Fisica Nucleare, Turin). Nuovo cimento (10) 9, 491-503(1958) Aug. 1.

Gel'fand and Levitan's procedure for the construction of a potential from the spectral measure function is simplified and made practical. Several theorems of purely mathematical character are also proved and their bearing on concrete problems exhibited. (auth)

**17910**

PAIR EFFECTS IN THE LEE MODEL. J. S. Goldstein (Brandeis Univ., Waltham, Mass.). Nuovo cimento (10) 9, 504-18(1958) Aug. 1.

The Lee model of an exactly soluble, renormalizable field theory is extended by allowing the meson to make nucleon pairs, introducing a new nucleon field for the purpose. The theory is still exactly soluble, with the following results; logarithmic divergences remain in the theory after renormalization, and the ghost state is shifted from the V-particle spectrum to the meson spectrum. (auth)

**17911**

CAUSALITY, COMPLEMENTARITY AND S-MATRIX FORMALISM IN 4 NON-LOCAL RELATIVISTIC THEORIES OF FIELDS. G. Wataghin (Univ. of Turin and Istituto Nazionale di Fisica Nucleare, Turin). Nuovo cimento (10) 9, 519-23(1958) Aug. 1.

A relativistic Lee model of interacting fields is discussed and the formalism of the proposed non-local theory is illustrated on this example. A general formulation of the causality and complementarity in non-local theories of fields is attempted. (auth)

**17912**

THE FEYNMAN FUNCTIONAL METHOD IN A SIMPLIFIED MODEL OF THE FIELD THEORY. R. Cirelli and A. Esteve Pastor (Univ. of Milan and Istituto Nazionale di Fisica Nucleare, Milan). Nuovo cimento (10) 9, 560-3(1958) Aug. 1. (In Italian)

The equivalence of the Feynman method to the ordinary methods of field theory is shown by applying it to a neutral scalar boson field in interaction with a nucleon of weight. (J.S.R.)

**17913**

EQUATION FOR VERTEX PART CORRESPONDING TO FERMION-FERMION SCATTERING. K. Ter-Martirosyan (Dept. of Physical Mathematic Sciences, U.S.S.R. Academy of Sciences, Moscow). Phys. Rev. 111, 948-50(1958) Aug. 1.

A system of equations is deduced whereby the vertex operator for fermion-fermion scattering and the Green's function are expressible in terms of the sum of contributions from a subset of all irreducible diagrams for the process. (auth)

**17914**

TWO-COMPONENT FERMION THEORY. Laurie M. Brown (Northwestern Univ., Evanston, Ill.). Phys. Rev. 111, 957-64(1958) Aug. 1.

The relativistic generalization of Pauli's equation for the electron has recently motivated Feynman and Gell-Mann to propose a specific form of universal Fermi interaction. Particles satisfying this equation are studied from the viewpoint of their electromagnetic interaction. It is found that an anomalous magnetic moment similar to the Pauli moment violates the Hermiticity of the theory, and that only vector and axial vector interactions lead to simple two-component equations, even with parity conservation. Rules for calculation in quantum electrodynamics are developed which have definite advantages over the usual Dirac formulation. (auth)

**17915**

REDUCTION OF PRIMARY CONSTRAINTS IN GENERALLY COVARIANT FIELD THEORIES. James L. Anderson (Stevens Inst. of Tech., Hoboken, N. J.). Phys. Rev. 111, 965-6(1958) Aug. 1.

Generally covariant field theories have associated with them, in the canonical formalism, a series of primary and secondary constraints. For a large class of these theories it is proven that there exists a transformation which will reduce the primary constraints to the form of a set of momenta equal to zero. The transformation which accomplishes this reduction is exhibited explicitly for the case of general relativity. (auth)

**17916**

THEORY OF THE INTERNAL SPACE. Walter E. Thirring (Univ. of Washington, Seattle). Phys. Rev. 111, 986-94(1958) Aug. 1.

It is postulated that fermions with identical space-time properties have to obey the exclusion principle unless they differ dynamically in their interaction with other particles. This postulate is formulated within the framework of a theory of the internal degrees of freedom. When all possible Yukawa-type couplings are examined, this postulate together with some other specification singles out the $\phi \cdot \tau$ interaction between pion and nucleon. Finally, when applied to electric interactions it requires the displacement of the nucleon center of charge. (auth)

**17917**

FORMULATION OF FIELD THEORIES OF COMPOSITE PARTICLES. K. Nishijima (Inst. for Advanced Study, Princeton, N. J.). Phys. Rev. 111, 995-1011 (1958) Aug. 1.

Based upon Feynman's over-all-space-time point of view, a general method for dealing with bound-state problems is presented. The Chew-Low or Lehmann-Symanzik-Zimmermann equations are generalized so as to include composite particles. The possibility of distinguishing between elementary and composite particles is examined. An investigation is made of how the S matrix elements for processes involving composite particles are related to those involving no composite particles. This problem is illustrated by the relation between $p + p \rightarrow n + p + \pi^+$ and $p + p \rightarrow d + \pi^+$. (auth)

**17918**

EXISTENCE OF POSITRONIUM IN SOLIDS. Mirza A. Bazi Bég (Univ. of Pittsburgh). Phys. Rev. 111, 1062-3 (1958) Aug. 15.

It is shown, in connection with a recent experiment, that it is impossible, in principle, to detect excited states of positronium within a solid or diffusing out of a solid. An experiment is proposed which would decide directly whether ground state positronium may be formed in a solid. (auth)

**17919**

FERMI-SEGRE FORMULA. L. L. Foldy (Case Inst. of Tech., Cleveland). Phys. Rev. 111, 1093-8(1958) Aug. 15.

A derivation of the nonrelativistic Fermi-Segre formula for the probability of finding a valence s-electron at the nucleus of an atom in terms of the energy eigenvalues of the electron is presented which makes use of the effective-range method drawn from scattering theory and a refinement of the JBWK method which avoids problems with the Coulomb singularity of the ion core potential. (auth)

**17920**

PROTON POTENTIAL ANOMALY AND NONLOCAL POTENTIALS. A. E. S. Green (Los Alamos Scientific Lab., N. Mex.) and P. C. Sood (Florida State Univ., Tallahasse). Phys. Rev. 111, 1147-54(1958) Aug. 15.

A detailed study of the variations of the difference between the proton-nuclear potential and the neutron-nuclear potential is carried out using ground-state mass data. A previous analysis of mirror nuclei has delimited the problem and suggested that the well difference can be neither constant nor strictly Z dependent. It is found by using analytical techniques as well as calculations performed with the Oak Ridge Oracle that the potential anomaly varies with the symmetry parameter $(N-Z)/A$ and that the proportionality constant does not change very greatly as one proceeds from a static well to a velocity-dependent well. This is somewhat surprising in view of many studies which suggest that the nuclear symmetry energy is considerably influenced by the velocity dependence of the nuclear potential. The relative insensitivity to velocity dependence or nonlocality is attributed to surface effects not taken into account in the analysis of infinite nuclear matter. A number of possible origins of the well differences are examined including (a) the failure of Koopman's theorem, (b) the breakdown of electrostatic laws, (c) the presence of Heisenberg forces, (d) the effect of the exclusion principle, and (e) the spin dependence of nuclear forces. It is concluded that the last two effects account for the bulk of the proton potential anomaly. Indeed, these last two effects suggest that the well depths used in neutron scattering and in proton scattering vary individually with the symmetry parameter, and it is suggested that experimentalists attempt to seek out these variations in careful, low-energy scattering experiments. (auth)

**17921**

MASS EFFECT IN P-STATE $\pi$-p SCATTERING. Hong-Yee Chiu (Cornell Univ., Ithaca, N. Y.). Phys. Rev. 111, 1170-3(1958) Aug. 15.

The mass difference between charged and neutral mesons was correlated to a change of the pseudovector coupling constant, giving rise to an additional term in the interaction Hamiltonian. The mass effect in P-state $\pi^-$-p scattering is then calculated, using Chew's fixed-source theory. A correction to the usual scattering formula for the $\pi^-$-p system is obtained. This correction fails to explain the quantitative feature of the observed difference $(\delta_{13}-\delta_{31})$. (auth)

**17922**

SPECTRAL REPRESENTATIONS IN PERTURBATION THEORY. I. VERTEX FUNCTION. Robert Karplus, Charles M. Sommerfield, and Eyvind H. Wichmann (Univ. of California, Berkeley). Phys. Rev. 111, 1187-90(1958) Aug. 15.

The vertex operator is examined in lowest order perturbation theory. It is found that, as a function of the invariant momentum transfer $q^2 = q^2 - q_0^2$, it is analytic in a cut plane with the branch point on the negative real axis. A spectral representation (dispersion relation) may therefore be inferred. The threshold of the spectrum depends on the masses of all fields involved unless certain inequalities hold between the masses of the incident and outgoing particles on one hand and the particles in intermediate states on the other; in that case the threshold depends only on the intermediate masses. (auth)

**17923**

NUCLEON SPECTRUM IN STRONG-COUPLING THEORY. L. Landovitz (Inst. for Advanced Study, Princeton, N. J.) and B. Margolis (Columbia University, New York). Phys. Rev. Letters 1, 206-7(1958) Sept. 15.

The question of whether there are any other low-lying states in the nucleon predicted by strong coupling meson theory is discussed. Using the Pauli-Dancoff theory, it is shown that there are states of order $g^6$ in the coupling constant and these need not have $j = t$. (W.D.M.)

**17924**

A NON-LINEAR THEORY OF STRONG INTERACTIONS. T. H. R. Skyrme (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Proc. Roy. Soc. (London) A247, 260-78(1958) Sept. 16

A non-linear theory of mesons, nucleons, and hyperons

is proposed. The three independent fields of the usual symmetrical pseudo-scalar pion field are replaced by the three directions of a four-component field vector of constant length, conceived in an Euclidena four-dimensional isotopic spin space. This length provides the universal scaling factor, all other constants being dimensionless; the mass of the meson field is generated by a $\phi^4$ term; this destroys the continuous rotation group in the iso-space, leaving a cubic symmetry group. Classification of states by this group introduces quantum numbers corresponding to isotopic spin and to strangeness; one consequence is that, at least in elementary interactions, charge is only conserved modulo 4. Furthermore, particle states have not a well-defined parity, but parity is effectively conserved for meson-nucleon interactions. A simplified model, using only two dimensions of space and iso-space, is considered further; the non-linear meson field has solutions with particle character, and an indication is given of the way in which the particle field variables might be introduced as collective co-ordinates describing the dynamics of these particular solutions of the meson field equations, suggesting a unified theory based on the meson field along. (auth)

**17925**

THE ANNIHILATION OF FREE POSITRONS ON A HELIUM ATOM AND A HYDROGEN MOLECULE. Li Chzhan. Vestnik Leningrad. Univ. Ser. Fiz. i Khim. (No. 1) No. 4, (1958).

The annihilation of free positrons by a helium atom and a hydrogen molecule was investigated. A zero momentum was assumed for the incident positron. The life of free positrons and the angular correlation of the emitted photons were calculated for the case of a helium atom using the plane wave positron function in the averaged field of the unpolarized atom and in the averaged field of the polarized atom. The calculation for the case of the hydrogen molecule was complicated by the lack of spherical symmetry, but it was performed by using the plane wave positron function. (J.S.R.)

**17926**

QUANTUM MECHANICAL PROBABILITIES AS SUMS OVER TRAJECTORIES. G. V. Ryazanov (Moscow State Univ.). Zhur. Eksptl'. i Teoret. Fiz. 35, 121-31(1958) July. (In Russian)

A new formulation of nonrelativistic quantum mechanics, that is, a general definition of the probability for any event is proposed. The physical content of quantum mechanics reduces to a single principle which is similar to the Gibbs principle and permits one to solve problems without making recourse to wave functions and operators. (tr-auth)

**17927**

ON THE THEORY OF WEAK INTERACTIONS. I. Yu. A. Golfand (Lebedev Inst. of Physics, Academy of Sciences, USSR). Zhur. Ekstpl'. i Teoret. Fiz. 35, 170-7(1958) July. (In Russian)

A scheme of a universal four-fermion interaction is proposed which differs from the usual schemes by the method of introduction of quantized field in the theory. Electron and positron $\beta$-decays are described by different Fermi interaction variants. The CPT-theorem is invalid but the theory is invariant with respect to CP, CT, and PT transformations. Various experimental and theoretical consequences are discussed. (tr-auth)

**17928**

ON THE DAMPING OF ELECTROMAGNETIC WAVES IN MAGNETIC FIELD PLASMA. K. N. Stepanov (Inst. of Physics and Tech., Academy of Sciences, USSR). Zhur. Eksptl'. i Teoret. Fiz. 35, 283-4(1958) July. (In Russian)

**17929**

ON THE NEUTRINO THEORY. V. V. Chavchanidze and M. E. Perel'man. Zhur. Eksptl'. i Teoret. Fiz. 35, 296-8(1958) July. (In Russian)

It is shown that experiments described by two-component theory can be described without utilizing the linear (non-symmetric) neutrino. (R.V.J.)

## Tracer Applications

**17930**

DIFFUSION ALONG DISLOCATIONS. G. P. Williams, Jr. and L. Slifkin (Univ. of North Carolina, Chapel Hill). Phys. Rev. Letters 1, 243-4(1958) Oct. 1.

Thin layers of $Au^{198}$ were deposited on the ends of cylindrical single crystals of silver and diffusion measurements at three temperatures were made using the standard sectioning procedures. (W.D.M.)

## Uranium and Uranium Compounds

*Refer also to abstracts 17326 and 17327.*

**17931** CF-58-9-24

Oak Ridge National Lab., Tenn.

REVIEW OF THERMAL CONDUCTIVITY AND HEAT TRANSFER IN $UO_2$. V. J. Tennery. Sept. 3, 1958. 31p. Contract [W-7405-eng-26]. $4.80(ph OTS); $2.70(mf OTS).

The theories of heat transfer in insulators are reviewed and discussed relevant to $UO_2$. As the rate of heat transfer from a reactor core is determined largely by the thermal conductivity of the fuel, this coefficient is of paramount importance in improving the efficiency of an installation. There is no theoretical basis to expect small or moderate chemical additions to increase the thermal conductivity of $UO_2$ when the oxide is classed as an insulator. Large additions of a phase having a high thermal conductivity have been found to increase the net conductivity. Such systems were two phase and had poor sintering characteristics. Considering $UO_2$ as a potential oxidic semiconductor, there is a possibility of increasing the thermal conductivity by proper doping. Thermal conduction by intrinsic carriers was treated experimentally and theoretically, and the conductivity values of the two cases do not presently agree, i.e., the Wiedemann-Franz law is not obeyed. The extrinsic case such as a doped oxide has not been treated theoretically. Recent measurements indicate that doping $UO_2$ with $Y^{+3}$ and $Nb^{+5}$ increases the thermal conductivity. These data are sparce; the magnitude of the increase and its dependence upon impurity concentration and temperature have not been determined. (auth)

**17932** HW-56631

General Electric Co. Hanford Atomic Products Operation, Richland, Wash.

BURNUP AND SPECIFIC POWER CALCULATIONS FOR THE THERMAL NEUTRON IRRADIATION OF THORIUM–URANIUM ALLOYS. A. L. Bement. July 14, 1958. 22p. Contract W-31-109-Eng-52. $0.75(OTS).

Thorium–uranium alloys are being irradiated in the MTR to aid in interpreting the irradiation damage observed in uranium and to extend the knowledge of irradiation damage to fuel systems. The design and scheduling

of irradiation tests for these materials generally requires prior knowledge of the percent burnup of fissionable atoms and specific power generation as a function of thermal neutron flux and time. Although these data have been determined for pure thorium, it is necessary to extend this information to thorium–uranium alloys in view of their potential importance. Graphs constructed from the relationships presented in this report and covering a small but useful range of flux densities and irradiation times are included for three alloys: thorium–1 wt. % oralloy and thorium–5.4 wt. % oralloy. (A.C.)

**17933** AEC-tr-3374

THE ELECTRICAL CONDUCTIVITY OF URANIUM OXIDES. Karl Hauffe. Translated for Los Alamos Scientific Lab., N. Mex. from Z. physik. Chem. 48B, 124-30(1941). 6p.

The electrical conductivity of $UO_2$ and $U_3O_3$ was measured in the temperature range 800 to 1000°C barostatically, applying varying oxygen pressures. In the pressure range utilized the electrical conductivity is in both cases independent of the oxygen pressure. The energy increment $\Delta E$ of the $U_3O_8$ phase electrical conductivity was calculated to be 5 kcal in the 700 to 900°C temperature range. (auth)

**17934**

A STUDY OF THE SELF-DIFFUSION OF URANIUM IN THE GAMMA PHASE. Yves Adda and Alexis Kirianenko. Compt. rend. 247, 744-6(1958) Sept. 1. (In French)

The self-diffusion of uranium was studied on diffusion couples made of natural uranium and uranium enriched in $U^{234}$. The coefficients of self-diffusion of uranium in the gamma phase as well as the activation energy and the frequency factor were determined. (tr-auth)

**17935**

ADIABATIC ELASTIC MODULI OF SINGLE CRYSTAL ALPHA-URANIUM. E. S. Fisher (Argonne National Lab., Lemont, Ill.) and H. J. McSkimin (Bell Telephone Labs., Murray Hill, N. J.). J. Appl. Phys. 29, 1473-84(1958) Oct.

The adiabatic elastic moduli at 25°C for single crystal alpha-uranium are reported here as derived from measurements of high-frequency ultrasonic wave velocities. A detailed description is given of the specimens used, and of the technique employed for obtaining small plates of proper orientation suitable for the problem. Although the specimens were small the technique of measurement produced results of relatively good precision, as evidenced by the numerous cross checks obtained. Best values of the moduli and the estimated probable errors are given. The elastic stiffness moduli in units of $10^{12}$ dynes/cm$^2$ are as follows: $c_{11} = 2.147 \pm 0.14\%$, $c_{12} = 0.465 \pm 0.6\%$, $c_{13} = 0.218 \pm 1.5\%$, $c_{22} = 1.986 \pm 0.14\%$, $c_{23} = 1.076 \pm 0.34\%$, $c_{33} = 2.671 \pm 0.14\%$, $c_{44} = 1.2444 \pm 0.10\%$, $c_{55} = 0.7342 \pm 0.10\%$, $c_{66} = 0.7433 \pm 0.10\%$. (auth)

**17936**

A QUALITATIVE INVESTIGATION OF THE WAVE FUNCTIONS OF METALLIC URANIUM. E. Cicely Ridley (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Proc. Roy. Soc. (London) A247, 199-213 (1958) Sept. 16.

The potential field and wave functions in metallic uranium have been calculated approximately by determining Hartree self-consistent fields for the four configurations $(6d)^6$, $(5f)^2\ (6d)^2\ (7s)^2$, $(5f)^4\ (6d)^2$, and $(5f)^6$ using the Wigner-Seitz boundary condition at the surface of the equivalent atomic sphere. In the self-consistent field obtained for each configuration, wave functions falling to zero at the surface of the sphere were evaluated for the outer electrons. The differences between the Hartree $\epsilon$-parameters for the two boundary conditions were used to give an indication of the relative band widths. The (5*f*) wave function has its principal maximum inside the (6s) (6p) shell, but is appreciable at the surface of the sphere and must participate in bonding. The binding energy of an electron in the (5*f*) wave function is 0·3934 rydbergs in the configuration $(5f)^2\ (6d)^2\ (7s)^2$ as given by the Hartree $\epsilon$-parameter. The (6d) function has its maximum charge density at the boundary and, with a binding energy of 0·1749 rydbergs in the same configuration, is likely to form a good metallic band. The (7s) function has a large negative binding energy and is not likely to occur. In the configuration $(5f)^2\ (6d)^2\ (7s)^2$ the band widths of the (5*f*), (6d) and (7s) functions are in the ratio 1:9·8:22·7. As the number of (5*f*) electrons is increased all the binding energies decrease and the band widths increase. At the same time the (6s) and (6p) functions are markedly perturbed, the functions (5s), (5p) and (5d) to a lesser extent. (auth)

**17937**

FISSION MATERIAL. IV. A. A. De Boer. R C N Bull. 2, 83-5(1958) July. (In Dutch)

The various ways in which energy can be produced from natural uranium are discussed. The enrichment of uranium, fast reactors, and the fission cycle are also described. (tr-auth)

# PATENTS

## Chemistry

**17938**

PRODUCTION OF NIOBIUM. A. E. Williams, P. B. Eyre, and J. Jackson (to U. K. Atomic Energy Authority). British Patent 791,121. Nuclear Eng. 3, 414(1958) Sept.

To initiate the reaction, potassium niobium fluoride, in admixture with a small stoichiometric excess of sodium metal (10%), is heated in an inert atmosphere. After conclusion of the reaction, the products are maintained at a temperature (1,100°C) above the boiling point of sodium, to distill off the excess of that metal, and of any potassium. The products, after cooling, may be crushed and leached with water, to remove soluble salts.

**17939**

OPPOSED IMPELLER MIXER - SETTLER. J. A. Dukes and F. Parish (to U. K. Atomic Energy Authority). British Application 03406/56. Atom No. 5, 23(1957) Mar.

It is usual to achieve flow through a mixer-settler plant by gravity fall or with interstage pumping (e.g. air lift, screw, or centrifugal pumping). The level mixer-settler plant is operated without the need for pumping by virtue of the fact that homogeneous mixing is maintained throughout the volume of the mixers. This is achieved by use of a double paddle mixer, one paddle being above the mixer outlet port and one below. The paddle operates in such a way that the lower paddle tends to lift the heavier phase while the upper paddle tends to depress the lighter phase.

**17940**

BATCH FRACTIONAL LIQUID-LIQUID EXTRACTIONAL PROCESS. D. W. Fosbury (to U. K. Atomic Energy

Authority). British Application 3563/56. Atom No. 5, 23-4(1957) Mar.

The components of a mixture to be separated are dissolved in a suitable solvent (the first solvent) the solution is brought into intimate contact continuously with a substantially immiscible solvent (the second solvent) which will preferentially extract one or more component from the solution, the extract is contacted with a phase obtained by stripping from the second solvent with the first solvent the component or components still held by the second solvent after contacting with the said phase and, when a steady state has been reached in the system, a portion of the said phase is continuously withdrawn as product. By appropriate selection of the second solvent all the components of a mixture may be separated consecutively.

**17941**

ION-EXCHANGE RESINS COMPRISING ALLYL ALPHA-AMINOALKYL PHOSPHONATE POLYMERS. J. Kennedy (to U. K. Atomic Energy Authority). British Application 14485/56. Atom No. 9, 27(1957) July.

These polymers are prepared by reacting the polymer of diallyl hydrogen phosphonate with an aliphatic ketone or aldehyde and a primary or secondary amine or with an aldehyde-imine, ketone-imine, or alpha-alkylolamine, and then hydrolyzing the product. The resins have a high affinity for cupric and ferric ions, and have a greater affinity for divalent transition metal ions than for uranyl ions.

**17942**

MEANS AND METHOD OF TREATING WATER. P. A. F. White and A. A. Smales (to U. K. Atomic Energy Authority). British Patent 790,474. Nuclear Eng. 3, 414(1958) Sept.

Removal of small quantities of radioactive substances from contaminated water (residual radioactivity of aqueous effluent) is effected by a precipitate formed from tannic acid and a soluble calcium compound under alkaline conditions. This is maintained in the water for a period of 3 to 5 hours, and the precipitate is then separated.

**17943**

URANIUM FLUORIDE SEPARATION OF PLUTONIUM AND FISSION PRODUCTS FROM IRRADIATED URANIUM. (To Atomic Energy of Canada, Ltd.) British Patent 791,000. Nuclear Eng. 3, 414(1958) Sept.

Uranium tetrafluoride and/or uranium trifluoride is added to neutron irradiated uranium, which is then heated in an inert atmosphere to a temperature of 1,135 to 1,350°C to melt the uranium. The uranium phase and the salt phase are separated by distillation or by gravity separation. For 100 parts of uranium 1 to 50 parts of uranium tetrafluoride may be used.

**17944**

PRODUCTION OF NIOBIUM COMPOUNDS. R. W. Blundell (to U. K. Atomic Energy Authority). British Patent 619/56. Atom No. 4, 16(1957) Feb.

Niobium containing material is digested with aqueous caustic potash of at least 50% concentration at a temperature in the neighborhood of but not exceeding 120°C. The resulting solution may be treated with hydrofluoric acid with hydrofluoric acid and the potassium fluoniobate recovered and recrystallized. By employing a temperature not exceeding 120°C and using a high potassium hydroxide concentration any iron present is kept in the form of black $Fe_3O_4$ and not as the brown $Fe_3(OH)_8$ which keeps niobium in the residue.

**17945**

SHIELDS FOR NUCLEAR REACTORS. I. J. Lockyer (to The Morgan Crucible Co. Ltd.). July 9, 1958. British Patent 797,692. Nuclear Power 3, 462(1958) Sept.

The graphite must be substantially free from harmful contaminants such as cobalt or zinc, which become radioactive, or the toxic halogens. The graphitic mix is made into blocks by consolidating it in increments in a mould with a pneumatic hammer and then heat treating it at about 1000°C to melt the boron. The proportion of boron varies according to the neutron absorption required but generally ¼% or more by weight provides effective neutron shielding.

## Physics

**17946**

MULTIPACTOR VALVE WITH MAGNETIC FIELD. M. C. Hartnell-Beavis (to U. K. Atomic Energy Authority). British Application 35985/55. Atom No. 4, 16(1957) Feb.

An electronic valve in accordance with the present invention comprises a perforated cylindrical sheet cathode one surface of which is adapted to emit electrons and has a maximum secondary emission coefficient greater than unity, an electrode coaxial with and facing the other surface and means for setting up in the electrode/cathode space both an axial magnetic field and a radial R. F. alternating electric field, the arrangement and applied fields being such that electrons emitted from the emissive surface return towards and either pass through or strike said surface, those passing through being collected by the anode.

**17947**

Y-TUBE MASS SPECTROMETER. J. Bishop and P. B. F. Evans (to U. K. Atomic Energy Authority). British Application 03005/56. Atom No. 5, 23(1957) Mar.

This spectrometer has a Y-shaped body tube. Ion sources are located at the ends of two arms of the tube and a common collector at the end of the third arm. The tube is associated with a single magnet system and the direction of the magnetic field in the tube is controlled so that the ion beam from only one source is deflected into the collector but, by reversing the magnetic field, the ion beam from the other source is deflected into the collector instead. Thus two sources can be handled with only one evacuation operation which is usually a time-consuming step. It is possible to arrange for four sources to feed two collectors with a common magnet system.

**17948**

SCREW OPERATED CONTROL ROD MECHANISM WITH MAGNETIC RELEASE GEAR. G. E. Lockett (to U. K. Atomic Energy Authority). British Application 03269/56. Atom No. 5, 23(1957) Mar.

A control mechanism comprises a substantially vertical externally threaded hollow shaft, a rod passing coaxially through the hollow shaft, means for connecting the top of the rod to a control element, quickly releasable means connecting the rod and hollow shaft such that when the means connecting the rod and shaft are disconnected the rod and associated control element fall under gravity into a "shut off" position, a drive nut on the hollow threaded shaft, mounting means for the drive nut, and means preventing the rotation of the hollow shaft such that rotation

of the drive nut in the appropriate sense moves the shaft and connecting rod in a direction such that the control element is raised into an "on" position, or lowered into an "off" position.

**17949**

DIELECTRIC WAVEGUIDE WINDOW. A. E. Barrington (to U. K. Atomic Energy Authority). British Application 17108/56. Atom No. 9, 27-8(1957) July.

Dielectric windows are used when it is desired to transmit power from one part of a microwave system to another, but to maintain a gas-tight seal between the two parts. Existing dielectric windows comprise irises so dimensioned as to be resonant at the operating frequency, but such windows suffer from the disadvantage that the thickness of the dielectric material must be controlled to within close limits. The dielectric window described comprises a length of waveguide filled along a portion of its length with dielectric material, the cross-sectional dimensions of the wave-guide being related to the operating frequency and the dielectric constant of the material in such a way as to maintain the same impedance to E-mode waves in the filled and unfilled portions of the waveguide. The thickness of the window is determined by mechanical considerations. The use is restricted to modes of waveguide propagation having transverse magnetic fields, i.e. E-mode waves, but conventional forms of waveguide transformer can be used on either side of the window if other modes of propagation are desired.

**17950**

FUEL ELEMENTS FOR USE IN NUCLEAR REACTORS. I. H. Morrison (to U. K, Atomic Energy Authority). British Patent 790,389. Nuclear Eng. 3, 414(1958) Sept.

It has been found that magnesium and magnesium alloys as sheath material have the undesirable property of cumulative stretching owing to their large coefficient of thermal expansion coupled with softening and deformation under pressure (on cooling, friction forces prevent free contraction). This can be overcome by providing concavities in the fuel element into which fit indentations made in the sheath, e.g., by circular grooving of the fuel rod and pressurizing the sheath on the rod to fill the grooves.

**17951**

HEAT TRANSFER ARRANGEMENTS. D. A. Boyland (to General Electric Co., Ltd.). British Patent 790,688. Nuclear Eng. 3, 414(1958) Sept.

The difficulties of gas-cooling are overcome by the arrangement of the path of the coolant gas transversely to the fuel elements, e.g., by ducts for the flow of coolant on each of two opposite sides of the fuel elements, one serving as the inlet, the other as an outlet, so that the coolant flows across between the transverse cooling fins. The flow may be controlled by decreasing the cross-section of the inlet duct in the direction of flow, and at the same time increasing that of the outlet.

**17952**

URANIUM–NIOBIUM ALLOYS. P. C. L. Pfeil (to U. K. Atomic Energy Authority). British Patent 790,991. Nuclear Eng. 3, 414(1958) Sept.

Alloys of uranium and niobium as fuel elements in nuclear reactors (containing from 0.1 to 6% by weight niobium, the remainder being uranium) show improved corrosion resistance and increased hardness compared with pure uranium. If the percentage of niobium is increased (over 6 to 20%) then the phase of uranium is stabilized down to relatively low temperatures. Such alloys may undergo repeated thermal cycling without change of structure. If a very high percentage of niobium is present (at least 60, preferably 75%) and the remainder is uranium highly enriched with $U^{235}$ or $U^{233}$, or both, and/or $Pu^{239}$, the alloys may be used in fast fission nuclear reactors, the niobium serving as a diluent for the fissile uranium. Niobium raises the melting point from 1,130 to 2,550°C according to its percentage in the alloys.

**17953**

NUCLEAR REACTORS. W. E. Dennis and P. A. Lindley (to General Electric Co., Ltd.). British Patent 791,011. Nuclear Eng. 3, 414(1958) Sept.

In gas-cooled nuclear reactors the avoidance of mechanical abrasion in the fuel channels of the reactor core during charging and discharging operations is one of the problems to be solved. Other problems are to avoid chemical attack on the moderator by the gas with or without mass transfer of moderating material, and to overcome the effects of radioactive contamination which would render the channel unsuitable for further use. The problems were solved by housing one or more fuel elements, within a tubular member constituting a lining or part lining for a channel, and forming, together with the fuel element, a replaceable unit. The gas then flows through the tubular member to abstract the heat from the fuel elements which are spaced away from the inside wall of the member which may be made of moderating material.

**17954**

SCINTILLATION MATERIALS AND METHODS OF MAKING SAME. (To Armour Research Foundation, U.S.A.) British Patent 792,071. Nuclear Eng. 3, 414 (1958) Sept.

It has been discovered that the scintillation characteristics of a single crystal scintillator can be closely approximated by an autogeneously bonded polycrystalline compact made from a compacted mass of microcrystals of a host compound, permitting propagation of energy derived from nuclear radiation and an activator capable of fluorescence under the influence of such energy. It is not essential, as previously thought, to have a completely regular orientation of the host crystal ions as in the large single crystals hitherto used as scintillation phosphors. The compact is made of sodium iodide as host compound and 0.005 to 1% by weight of thallium interspersed therein as activator.

**17955**

NUCLEAR REACTORS. (To Stichting Reactor Centrum Nederland, Netherlands). British Patent 792,113. Nuclear Eng. 3, 414(1958) Sept.

The reactor operates with a mixture of fissile material and heat carrying material (moderating material) circulated continuously through the reaction zone and a separate cooling zone. The mixture is formed of a powdery mass which passes downwards through the reaction zone under gravity, but is transported upwards through the cooling zone by fluidization caused by injection of gas. The fluidized mass should have a density only 20% (and preferably only 10%) less, than that of the unfluidized mass. The separation of the fluidizing gas from the mass at the top of the cooling zone is effected by gravity only. In order to keep the difference in density as low as possible, resistance to flow must be kept small by the largest possible cross-sections of all channels, lines and ports. The fluidizing gas should have a small neutron capture cross-section. The heat carrying material may also contain breeder material. The reactor may be homogeneous but may also contain the moderator as a stationary mass in the reaction zone.

**17956**

NUCLEAR REACTORS. (To Stichting Reactor Centrum Nederland, Netherlands). British Patent 792,114. Nuclear Eng. 3, 414(1958) Sept.

When a reactor is operated with a mixture of fissile and heat-carrying material, circulating continuously through the reaction zone and a separate cooling zone, certain particle sizes are to be preferred in consideration of the techniques of fluidization and heat transfer. The size of the particles should be between 50 and 300 microns with an optimum of approximately 175 microns. Their porosity should permit escape of any gaseous reaction products formed in the particles. The heat-carrying material will be constituted by chemically non-reactive elements with a neutron capture cross-section smaller than 0.1 barns per atom. The mixture is prepared from sintered baked or cemented aggregates of smaller particles of heat-carrying material soaked in a solution containing fissile material.

**17957**

IMPROVEMENT IN AIRCRAFT PROPULSION. (to Societé Rateau and René Anxionnaz). July 23, 1958. British Patent 798,617. Nuclear Power 3, 462(1958) Sept.

The propulsion unit comprises a multi-stage, axial-flow compressor delivering air through the channels of a reactor, a number of combustion chambers, and the nozzles and rotor blades of a turbine, finally discharging it through an ejection nozzle. When the aircraft is on or near the ground the reactor is shut down, the air passes through it without heating and the combustion chambers are fed with hydrocarbon fuel so that the unit becomes a conventional turbo-jet. There is a pressure loss between the compressor and combustion chambers prevented by a modification of the idea in which these units are parallel.

**17958**

IMPROVEMENTS RELATING TO NEUTRONIC REACTOR FUELS. (to General Electric Co., U.S.A.). June 25, 1958. British Patent 796,989. Nuclear Power 3, 462(1958) Sept.

To keep the value of k virtually constant over a long period of time without changing the reactor controls, a fuel element is proposed with neutron capturing characteristics which change at a constant rate. It consists of $U^{235}$ alloyed with either aluminum or zirconium and containing a fine, even dispersion of $B^{10}$. As the reaction proceeds, the boron ($\sigma$ = 3990 barns) is gradually transmitted to $Li^7$ ($\sigma$ = 33 millibarns) at a rate proportional to the fission process. Thus, as the uranium is consumed, the number of neutrons removed from the reaction is proportionally reduced. Suitable proportions for the alloy are 15 to 23 wt. % U, 0.1 to 0.5 natural boron (which contains 18.8% $B^{10}$) and the balance aluminum or zirconium.

**17959**

IMPROVEMENTS IN LOW TEMPERATURE REACTORS. (to Allmänna Svenska Elektriska Aktiebolaget). July 2, 1958. British Patent 797,485. Nuclear Power 3, 462 (1958) Sept.

In this heavy-water reactor operating at about 130°C, both moderator and coolant are under the same pressure. The aluminum reactor vessel cannot be made sufficiently thick to withstand the pressure required to prevent boiling and consequently is surrounded by a steel pressure vessel which can withstand 7 atmospheres. The interspace is filled with a reflector—either graphite or heavy water. The reactor vessel cover is the collecting vessel for the heavy water which is sucked through tubes in which the fuel rods are suspended, through the heat exchangers and back to the reactor vessel. The tubes are attached to the bottom of the collecting vessel, the fuel rods to its cover with which they can be removed as a composite unit.

**17960**

IMPROVEMENTS IN OR RELATING TO FUEL ELEMENT FOR NUCLEAR REACTORS. G. D. Bell (to United Kingdom Atomic Energy Authority). July 16, 1958. British Patent 798,282. Nuclear Power 3, 462 (1958) Sept.

One of the factors limiting fuel element temperature is the creep strength of the sheath material. Designed for a graphite-moderated, sodium-cooled reactor, this arrangement ensures that the part of the sheath supporting the weight of the cartridge is kept cool. The fuel element is cylindrical, enclosed in zirconium sheaths, the inner one being pressurized tight on to uranium and the outer, spaced from it at a uniform 0.1 in. insulating gap, filled either with air or solid insulator such as magnesia. The outer sheath carries the weight of the element via the rigid end cap. The channel has a zirconium lining which encloses all the graphite. Incoming sodium flows downwards round the element keeping the outer sheath moderately cool, and up through the inner sheath where most of the heat transfer takes place.

# PERSONAL AUTHOR INDEX

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